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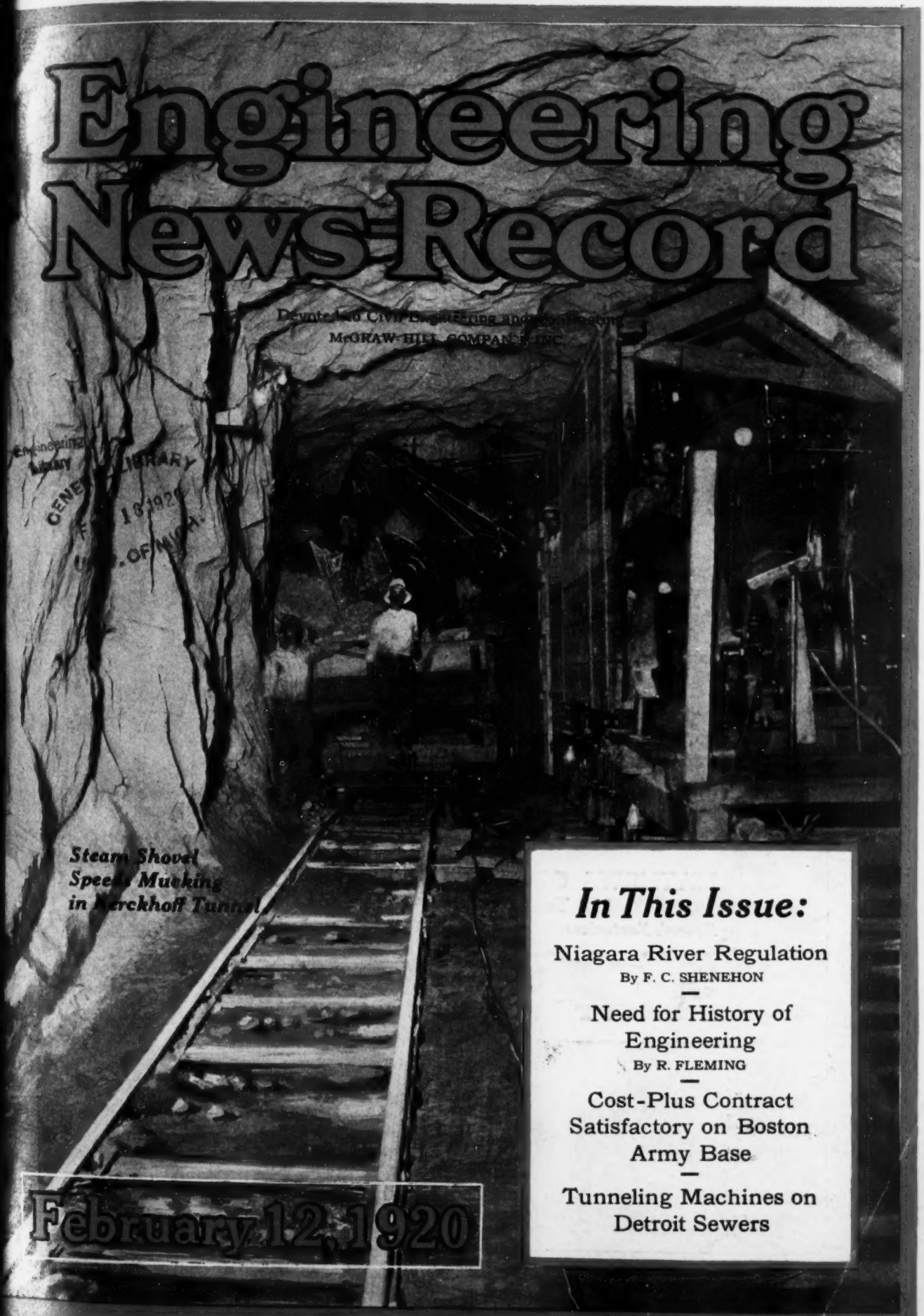


Steam Shovel Speeds Mucking in Nerckhoff Tunnel

February 12, 1920

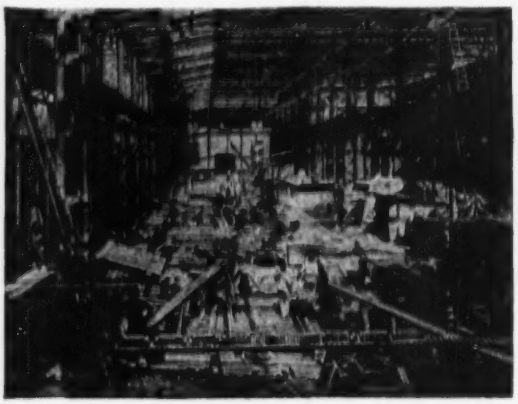
In This Issue:

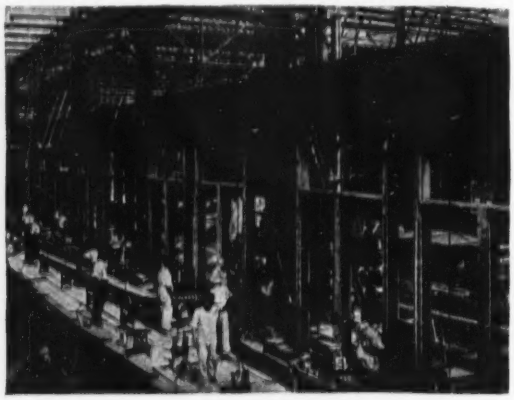
Niagara River Regulation
By F. C. SHENEHON

Need for History of Engineering
By R. FLEMING

Cost-Plus Contract Satisfactory on Boston Army Base

Tunneling Machines on Detroit Sewers





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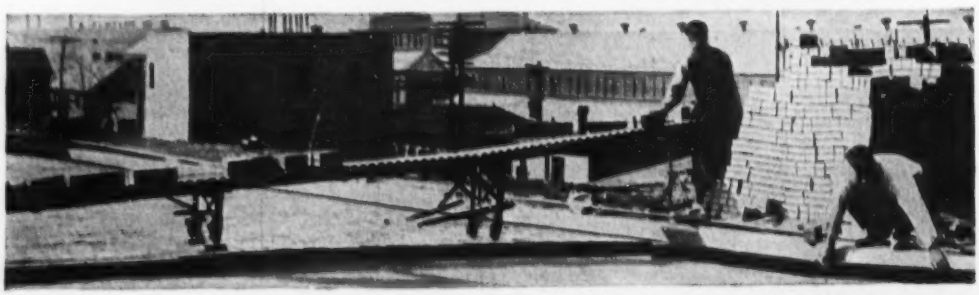

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. Mehren
Editor

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The Obligation To Vote

THERE will be sent out shortly, from the headquarters of the American Society of Civil Engineers, the questionnaire-ballot on the fundamental recommendations of the Committee on Development. The results of the ballot are to determine for many a year the future of the American Society of Civil Engineers, and because of the society's influence, that future necessarily has a great bearing on the status of the engineering profession in this country. Every corporate member of the society, therefore, has a solemn duty: to give the questions his most serious consideration and to cast his ballot thereon. The Committee on Development was formed that it might help to build the society into an institution of greater usefulness. Whether for good or ill—and we think for good—the recommendations are now in, and it is in the hands of the membership to determine whether they shall be accepted or rejected. Apathy in this case is a serious dereliction of duty.

Railroad Facts for the Public

LATTERLY the Association of Railway Executives has begun the publication in the daily press of a series of advertisements which show the extent of the unfairness of the treatment accorded the railroads. A statement of fact such as the following, if repeated often enough, will get under the skin of even the unthinking: "A suit of clothes that sold for $30 before the war was carried 2,265 miles by rail from Chicago to Los Angeles for 16½c. Now the freight charge is 22c. and the suit sells for $50. *The cost of the suit has increased* $20*; the freight on it has increased only* 5½c." Similar illustrations, our readers will remember, were presented by Charles Whiting Baker in his monograph on the railway situation published in these pages last autumn. It is regrettable that the railroad executives did not begin long ago to lay these facts before the public. The public wants to be fair, but unfortunately they have been misled by demagogues. We hope that the executives will keep up their present propaganda. Continued intensively, it will have favorable results.

Shortage of Railroad Facilities

THE Railroad Administration within the last two weeks has issued warnings regarding the serious shortage in railroad equipment, and the Director-General has asked the shippers for hearty co-operation in order to minimize the seriousness of the situation as far as possible. That which we are running into has long been foreseen by students of the railroad problem. Our readers know the situation well, and for those who desire to refresh their memories we would refer to the review of the financial and physical status of the railways published on p. 12 of the *Engineering News-Record* of Jan. 1, 1920. Unfortunately, however, the business community is only now beginning to awake to its seriousness. We have not by any means experienced the worst. Last year highway construction was curtailed and so was the shipment of coal. But, as our industries begin to get into something approximating pre-war production, we shall find shortage pressing from every side. There will come cries from the steel districts, from the miscellaneous manufacturing states of New England, from the lumber region; each week will bring its complaint of unsatisfied demand for railroad transportation. The public then will begin to awaken to that which has been done in the failure to keep up our railway systems. The relief will come, belated indeed, and only after there has been a severe setback to our industries. The worst of the situation is still before us.

Regulating the Largest Reservoir

HYDRAULICS on the grandest conceivable scale is involved in the Niagara regulating works proposed by the Chicago Sanitary District, and outlined by Mr. Shenehon elsewhere in this issue. To control the level of that stupendous natural reservoir known as the Great Lakes by man-made devices is engineering in its highest form. And yet it is something which has been proposed and even projected for many years. The present plan is novel only in the type of works proposed. Movable dams are common enough, but a removable dam is a new thing in engineering science and, for the size here designed, one which will have much opposition to overcome. It is true, as the designer says, that there is ample precedent for the floating into place of large structures to be sunk to a sub-aqueous foundation, but such structures once footed have remained in permanent location. The four large units of the Niagara butterfly-dam will have to be placed and removed every year, thus multiplying indefinitely the hazards of the operation. Nor is the drydock or lock floating-caisson precisely analogous, for they are placed and removed in still water, with all the accompanying security of lines to, and machinery on, nearby solid structures. However, the difficulties of the scheme have undoubtedly been considered by the proposers and it will be interesting to every engineer to watch the progress the plan makes.

Valuation and a New Rate Rule

ALTHOUGH neither of the railroad bills before Congress designates the basis of value that shall be used in building up a new rate structure, it is apparent that a definite statement as to what the basis shall be must eventually be made. The Valuation Act calls for determination of (a) original cost, (b) cost of reproduction, (c) cost of reproduction less depreciation and (d)

other values and elements of value. But what value would be used as a basis for the new rate rules has not been made clear. It is probable that the strong systems will make a legal fight against the limitation of earnings on the grounds of confiscation of property. The "intangible" value of a property, indicated by income-producing qualities and entirely separate from physical value, will become a principal point at issue. In any event, it will be necessary to establish an interim arrangement until the valuations are in more complete form, with the possibility of the "standard return" being continued considerably beyond the transition period. But much may be left to the commission and to the courts that might well be determined in the law itself if Congress would indicate what basis of value is to be used in the new rate rule.

The Canadian Institute's Example

WE commend to the consideration of all members of the American Society of Civil Engineers a reading of the comments under "Impressions Here and There," on page 318 of this issue. The Canadian Society of Civil Engineers about three years ago went through much the same period as that which the American Society of Civil Engineers is now facing. The organization had proceeded along measured, conservative lines. Dissatisfaction had arisen and became so strong in the western provinces that there was talk of secession, culminating in a threat by the members in one of the provinces that an independent organization would be formed. The demand was for a type of organization that would make each member feel that he had a part in the work of the organization. The result of this agitation was the reorganization of the society, under the name of the Engineering Institute of Canada, based on the theory that strong branch and provincial organizations should be built up and that, in addition to the annual meeting, there should be one or more general meetings held away from the headquarters city, Montreal.

For about three years the organization has proceeded on the new lines. The result, as is evident from the spirit of the Montreal meeting and the testimony of individual members of the institute, has been good. The branches have become virile organizations, with the result that there is much greater activity, in both technical and general matters, than under the earlier form of organization. The membership, from being apathetic, is active and enthusiastic.

As we sense the situation in the United States, the criticisms made of the American Society of Civil Engineers are precisely those that were made regarding the Canadian body three years and more ago. The changes proposed by the Committee on Development follow along the very lines that have been pursued in Canada. The committee proposes a strengthening of branch and district organizations and the holding of additional professional meetings whereby a larger number of members may have an opportunity to attend gatherings of the society.

We have no doubt that the adoption of the recommendations of the Committee on Development will do for the American Society of Civil Engineers what the reorganization has done for the Engineering Institute of Canada. It is not mere coincidence that the demands in the two cases are similar. They spring from a fundamentally sound conception of methods of conducting a national body. The adoption of that fundamentally correct conception should have identical results in both cases.

If all members of the American Society of Civil Engineers could have attended the Montreal meeting of the Canadian Institute, could have queried the members and felt the enthusiasm, there would be no question as to a practically unanimous vote in favor of the fundamental recommendations of the Committee on Development. What Canada has done should be most encouraging to us.

Possibilities in Bridge Reinforcement

IT HAS been predicted more than once that in the coming development of engineering construction a place of special importance will be given to economy. The prediction may be realized soon in the field of bridge construction, if we can accept a conclusion that has been expressed by engineers of mature judgment. Certain noteworthy changes in the trend of bridge work are indicated, in which economy will be a prime factor.

The conclusion we refer to is that, in view of conditions both in the railway world and in the art of bridge building, railways must resort to reinforcement of existing bridges on a large scale during the next decade or two. The line of thought which leads to this belief may be applied also to highway bridges, and suggests that these too are likely to demand much reinforcement work. Thus we face the possibility that the little-developed art of bridge reinforcement will be called upon for extensive service in the near future. In that event many new technical problems will present themselves.

Changes in bridge conditions are responsible for bringing the subject to the front. A quarter century ago very few bridges were of a character to justify attempts at strengthening them or to make such work feasible. Modern railway bridges, on the other hand, are so well designed and built, with clearances and substructures so ample, that they offer attractive opportunities for reinforcement to suit heavier loading. Where reinforcement is at all practicable it will generally prove cheaper than rebuilding; and this economy is the crux of the matter. For, regardless of rate adjustments, the railways must for some years reckon with a limited income against an almost unlimited need for betterments and extensions.

There is occasional talk of a limit having been reached in railway loadings. But in view of the steady increase of loadings in the past it would seem inevitable that further increase must come about unless the development of transportation practice, with its progressive changes in cars, locomotives and track, comes to a stop. Even now many bridges of fairly modern design are loaded beyond their design capacity, and of course the condition of bridges over 15 years old is much less satisfactory. It is hardly subject to doubt that a great deal of work will have to be done sooner or later in order to bring all our railway bridges to full traffic capacity.

Somewhat similar considerations affect highway bridges, though there are still many ancient and virtually obsolete structures that must be renewed from the ground up. In one respect, however, load conditions affect the highway field less seriously. The heavy motor

trucks of the present era increase the concentration rather than the total amount of the load to be carried, and thus attack the floor and bracing more than the trusses. If floor reconstruction will make a structure adequate for modern service, it would obviously be wasteful to scrap the whole bridge and erect a new one. With this in mind it seems certain that a large field for reinforcement operations will develop in highway bridge service. On the other hand, it is safe to say that the technical problems involved will be much less important than those of railway bridge reinforcement.

Some interesting cases of strengthening have already been recorded. Among them are the Michigan Central and Poughkeepsie cantilevers, the Marshall Ave. arch over the Mississippi, and most recently the Niagara Gorge arch of the Grand Trunk Ry. Other work of equal interest, such as the modernization of the Red Rock and Steubenville bridges, has escaped recording. But all these cases indicate plainly that a remarkable variety and complexity of problems will be encountered in reinforcement work. However, they constitute but a small body of precedent on which the future development of the art might be based. Essentially the art will have to start as the beginning.

It is certain that the work to be done will call for engineering ability of high order. The problems will be different in many ways from those of new construction. Up to now they have had little or no systematic study, and it would be well if they were soon to receive the attention of bridge engineers, in preparation for the activities of the future.

The engineering thought by which bridge reinforcement operations must be governed is by no means identical with the thought that has been crystallized in our conventional bridge specifications. This has been said before now, but its meaning does not appear to have been followed out in detail. A full comprehension of what is required must be reached by individual study of the several factors that combine to determine the strength of a bridge. In such consideration it will appear, for instance, that the stress limitations set up for new bridges are inapplicable in estimating the condition of an existing bridge or planning the means of improving that condition; what counts here is the greatest stress caused by a given load and the margin between this and the corresponding crippling stress. Again, impact allowances derived from a formula which broadly averages the facts of very many bridges under various conditions have no meaning for the purpose, but instead the actual stress excesses produced in the particular bridge to be dealt with should be considered. Principles of detailing which will make a member safe for service at current unit stresses are of little or no value when an existing structure is examined, and should be replaced by principles enabling us to gage the effect of an existing detail, let us say for example a long weak-kneed pin fork. In similar manner it will appear that nearly all the clauses of existing specifications fail of application. We need for the new service a new assembly of experience data, something that no one has yet attempted to compile, though much of the material for it exists, in distributed form, in our societies of bridge engineers.

Two matters that lie beyond the scope of any mere experience compilation are so vitally related to all reinforcement work that they should be called to mind at this time. The first is the matter of estimating the utilizable strength of an existing member, whether before or after reinforcement. It involves allowable unit stress—which will likely depend on reasoning quite different from that used in fixing ordinary design units—as well as suitable deduction for deficiencies in the structural condition of the member as found. This last element depends on observation of the behavior of the bridge in service. Methods of conducting such observations have not been much discussed hitherto. We believe that it would be of permanent value if a thorough discussion were brought about, with a view to developing best practice.

In fixing safe stresses the judgment of the engineer is bound to be the determinative factor, for it is not likely that limits can ever be set by general rule. It is easy to fall into the view that, since the physical properties of the material are reasonably constant, and since the generally accepted methods of calculation purport to express the service of the material in precise quantitative terms, a fixed allowable unit stress will apply to all cases. We do not believe that this view is tenable. Further, the total load-carrying capacity of a given member is still more difficult to estimate, for it is affected by internal structural conditions that cannot always be evaluated. In practice, an estimate of these internal conditions must be made, by applying trained judgment to the results of close observation. An almost abnormally careful physical examination will in fact be required for this purpose in every case where the capacity of a bridge or its adaptability to reinforcement is a question.

The other matter we wish to suggest is the probability that strain-gage measurements will prove to be highly valuable, indeed indispensable, in planning and in executing reinforcement work. There is still a tendency among bridge engineers to take a "practical" view of strain-gage work and to hold that it yields only some higher refinements whose working value is negligible. Whatever justification this view may have with respect to the construction of a new bridge—though we are not willing to concede this justification—it is certain that the case stands quite otherwise in reinforcement work. The question at every point is, What stresses exist? Calculations can furnish only a partial answer, but a full answer is obtainable by measurement with the strain-gage.

Today very few bridge engineers are familiar enough with the instrument to use it in their revision inspections. Ordinarily the first quantitative knowledge concerning the condition of a bridge is obtained only when incipient failure of some detail occurs. It would frequently be of great value to obtain such definite knowledge earlier, by measurements made while a margin of strength still exists. When local weakness develops, however, measurement becomes quite vital; reinforcement planning cannot be based on the facts of actual conditions unless these facts are precisely determined, unless the distribution of stress throughout the structure—in detail parts as well as integrally in several members of the bridge—is known dependently and quantitatively.

We conclude from considerations of this kind that a great development of strain-gage practice is bound to come about. In the meantime anything that tends to stimulate this development is to be considered as desirable and worth encouraging.

Plan To Regulate Great Lakes Level by Niagara Dam

Chicago Sanitary District's Proposition of Removable Dam in River Near Buffalo Would Permit Maintenance of Lake Levels Above Present Stages and Still Allow Depletion for Power and Storage

By Francis C. Shenehon
Consulting Hydraulic Engineer, Minneapolis, Minn.

Regulating the level of the Great Lakes by works at the head of the Niagara River is no new proposal. As long ago as 1895 the Board of Engineers on Deep Waterways made such a suggestion, which never got beyond the report stage. Now, the project is once more brought forward by the Chicago Sanitary District, which proposes to build in the Niagara River, near Buffalo, regulating works which are unique for such a purpose in that the main channel closure is to be made by a dam in sections, roughly of boat shape, which are to be floated out to place every spring and locked in place, and every winter loosened and towed back to storage. Thus ice difficulties are to be avoided, but the summer level of the Great Lakes maintained for proper ship draft, in spite of the depletion due to the power and drainage canals leading from the lakes.—Editor.]

In commenting on the proposal of the Board of Engineers on Deep Waterways to construct regulating works at the head of the Niagara River to raise the levels of Lakes Erie, St. Clair, Michigan and Huron, *Engineering News*, in 1895, made the following editorial statement: "The control of the levels of these great fresh-water seas, covering a hundred thousand square miles, would be indeed the most stupendous physical effect ever produced by man's agency, but from present appearances it would be carried out by methods entirely within the precedents of modern engineering, and at a cost quite inconsiderable in comparison with the benefits to be secured."

FIG. 1. MAP OF GREAT LAKES SHOWING LOCATION OF PROPOSED REGULATING WORKS NEAR BUFFALO

The vessel freight passing through the Detroit River at that time, 1895, was 20 million tons; in 1916 it was over 100 million. In 1895 freight passing the "Soo" locks was carried for $\frac{1}{10}$c. per ton-mile; in 1914, prior to our entry into the war, the rate was 40 per cent less; and in 1917-18 only 20 per cent more. The same freight carried by rail would have cost five times as much. The value of the freight carried in 1917 was over 1¼ billion dollars; and the value of the vessels themselves over 250 million dollars. In July, 1918, a vessel passed through the Detroit River, on an average, every 10½ minutes, and each vessel carried an average of 3,300 tons of freight. This is a freight movement of over 300 tons per minute, with a freight value of over $3,400. As the average haul of the freight carried was over 800 miles, the significance of this continuous procession of loaded ships is apparent.

It is not purposed to confuse with too many statistics or figures the theme of this article, but the economic basis of the regulation of the Niagara River involves some citations. This water-transportation system is second in importance only to the high seas; and the vast volume of freight carried moves on waterways which, owing to limited vessel drafts, compare with the navigable ways of the ocean, as a narrow-gage railway compares with a standard-gage railway. It is necessary to inquire into vessel drafts on the Great Lakes, to point out the various impairments of these drafts, natural and artificial; and, as a guide to warranted expenditures for betterments, to reach an approximation of the money significance of a foot gain in loading capacity for the freight-carrying fleet. Up to the fall of 1895 drafts on through routes were mostly limited to 14 ft. The completion of the project of 1892 gave nominal 20-ft. drafts between Duluth, Chicago and Buffalo. The new third and fourth locks at the "Soo" have 24½ ft. over the mitor sills; the Welland Canal, between Lakes Erie and Ontario, is building for 30-ft. (ocean drafts) over the miter sills of the locks; and a channelization of the St. Lawrence for similar ocean drafts is a certainty.

A modern lake freighter will carry an additional 900 tons on each added foot of draft. The loading of such vessels in low-water periods is guided by telegraphic instructions as to the actual depths in the channels to be traversed. Every additional inch means 75 tons of cargo—and they load to the last available inch. The annual decreased carrying capacity of 350 vessels of the Great Lakes, capable of loading to 20-ft. drafts, but limited to 19-ft. drafts by shallow channel, is not less than five million ton-trips. With freight rates of

one dollar per ton, this means decreased gross receipts of five milion dollars a year for this fleet, without anywhere near a proportionate decrease of operating expense. A net economic loss of not less than a quarter of a million dollars a year for each inch of loss of draft is clearly indicated.

Why, with this economic loss long apparent, are the Great Lakes often low, if a remedy is practicable? What depleting artificial influences are operative, which need artificial works to offset them? What natural cycles of dry years or dry seasons have we become accustomed to accept as necessary evils in limiting drafts? Perhaps the answer to the first question is that the amazing reach of effect claimed for simple remedial works at the head of the Niagara River aroused the incredulity, rather than the conviction, of hard-headed practical men. Perhaps the very vastness of these inland seas, their irresistible might in storm-time and fears of floods made men hesitate in tampering with their natural operation. Perhaps it was just simple inertia, rendered still more absolute by the fact that these waters are under the sovereignty of two nations, not one.

The natural causes which periodically give high lake stages with alternate low lake stages are of two kinds: the regular annual cycles of high June levels, with the draining down to low levels in December, as the fullness of the abundant supply of spring passes out to the ocean; then the cycles which are of years instead of months due to variations of rainfall. The normal November stage of Lake Erie is lower by 12½ in. than the normal June stage; the stage during the season of navigation in 1895 was 20 in. lower than that of the season of 1908. These higher stages are wholesome for navigation, the low stages damaging.

When all contemplated artificial causes of the lowering of Lake Erie now visible are fully in effect, this lake will have a surface level lower by 10 in. than in a state of nature. This artificial lowering will subtract 10 in. more from the drafts of the November lows, and from the lows of such years of meager rainfall as 1895. These anticipated lowerings will result from the following diversions: 10,000 cu.ft. per sec. at Chicago, 5½ in.; 2,100 cu.ft. per sec. in Erie and Welland Canals, 1 in.; 55,500 cu.ft. per sec. for water power above the Cataract Rapids at Niagara Falls. Each of these diversions serves some useful purpose, even though each is at times in conflict with navigation, scenic grandeur or water power.

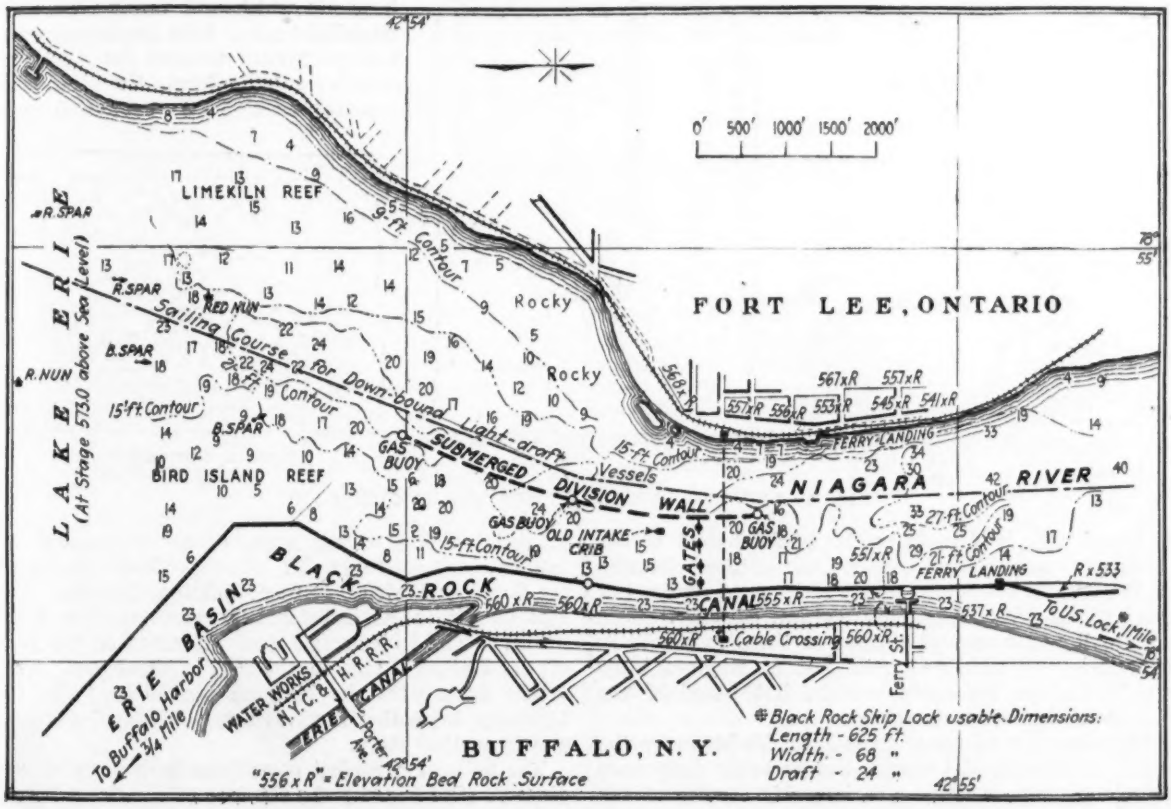


FIG. 2. NIAGARA RIVER NEAR BUFFALO WITH LAKE-REGULATING SUBMERGED AND REMOVABLE DAM

Assuming the normal June stage of Lake Erie (573.2) to be a desirable stage for navigation, it is enlightening to note the conditions which will obtain with all these diversions effective, and with the meager supply conditions of 1895 returned again. Here are the causes and the measure of their effects.

	Inches Lowering
Unrestrained natural outflow with deficient precipitation	23
Chicago Drainage Canal	5½
Erie and Welland Canals	1
Water Power at Niagara	3½
Total	33

Nature stands out conspicuously as the chief offender. Obviously, the natural operation of the outflow rivers of the Great Lakes serves only the ancient purpose of rushing the waters to the ocean. Obviously, also, the direction of the forces of nature to the end

that civilization may be better served, points to the retention of the surplus waters in their natural reservoirs, and their release under regulations, which will yield the largest benefits to navigation, water power and scenic repletion. That means regulating works and water release under a budget system.

Low-water depletion is the negative phase of lake levels. Opposed to this is the menace of stages too high for riparian welfare. In 1838 Lake Erie reached the record height of 575.1 ft. This is at least a foot higher than is now ever desirable; and any scheme of regulation must keep vividly in mind the return—once in a century perhaps—of such opulent supply that the lakes may be overfilled. The flood menace must be

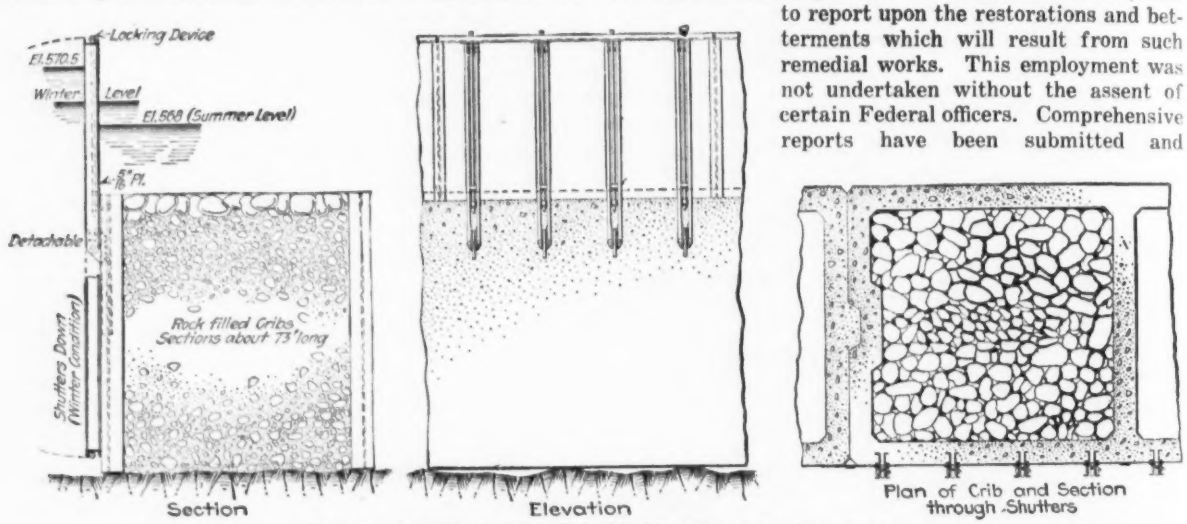


FIG. 3. GENERAL DETAILS OF SUBMERGED CRIB DAM

reckoned with, and leads to the establishment of the most vital principle of control: the outflow channels of the lakes must not be throttled by fixed works, but must retain their full natural outflow capacity. It is noteworthy that such diversions as those in the Welland, Erie and Chicago canals and at Niagara Falls are hurtful in low-water periods, but beneficial for flood relief in high-water times.

The diversion of water from Lake Michigan by the Sanitary District of Chicago, has probably done more than any other one thing to intensify studies of the hydraulics and physics of the Great Lakes system. The Chicago Drainage Canal was designed to lead 10,000 cu.ft. per sec. of water through the Illinois and Mississippi Rivers to the Gulf of Mexico. The effect of this diversion is to deplete by the same volume the flow through the various lakes and rivers leading to the Gulf of St. Lawrence. Chicago proceeded with its immense project to dilute and dispose of its sewage and at the same time avoid contaminating its water supply, without taking all the preliminary steps which any less confident community might have taken to secure its right to appropriate a volume of water equivalent to nearly twice the ordinary flow of the Mississippi River at Minneapolis. At the present time the Sanitary District finds itself with a Federal permit for 4,167 cu.ft. per sec. and an existing diversion probably twice that volume, after a series of years in the Federal Court endeavoring to minimize or justify the effect of its diversion on the interstate and international navigable waters of the Great Lakes. The suit was a friendly one, fought on principles, not personalities, as becomes an issue of law between a state and the general government. No decision has yet been handed down.

Secretaries of War Taft and Stimson in declining to authorize a diversion of 10,000 cu.ft. per sec. have, in effect, stated that Congress alone should assume responsibility for such diversion. Federal attorneys have taken the same view. Chicago is now appealing to Congress to legitimatize a diversion of 10,000 cu.ft. per sec. and offers to pay the cost of regulating works in the Niagara and St. Lawrence Rivers. The writer, after serving the Federal Government through the years of litigation, has been retained by the Sanitary District to design regulating works for these two rivers, and to report upon the restorations and betterments which will result from such remedial works. This employment was not undertaken without the assent of certain Federal officers. Comprehensive reports have been submitted and printed. Copies of the reports may be secured by application to George M. Wisner, Chief Engineer, the Sanitary District, Karpen Building, Chicago. The reports utilize as substantially accurate the basic hydraulic and hydrometric data presented on the part of the United States in the legal controversy. This article deals with the Niagara regulation. The St. Lawrence regulation involves some additional elements and is another story.

The scale of a project sometimes brow-beats an engineer. (See Fig. 1.) In the case of the Great Lakes, however, the far-flung geographic reach and the vast commercial importance, are elements which contribute to confidence, not embarrassment. Their importance has meant the accumulation of records of exact water surface elevations of each of the lakes, over a period of sixty years, many of the readings daily, and all digested in monthly means. Measurements of the volumes of flow of the St. Clair and Niagara Rivers, have extended over many years and have included for each river several hundred individual precise current-meter gagings. The accepted volume of flow of the Niagara River for a given stage of Lake Erie at Buffalo is precise within 2 per cent; and the law of outflow is so definite, that the change in volume of flow for a rise of a foot in Lake Erie is precise within 5 per cent. The surface profiles of both the Niagara and St. Clair Rivers, and the changes of profile with varying volumes of flow are definitely known; and the river depths and bottom contours are revealed by multitudes of soundings. The great spread of the drainage basins

(nearly 255,000 sq.mi. above the Niagara River) stabilizes the water supply, and eliminates the caprice of such rainfall centering as comes in little watersheds. The lakes themselves, with more than 87,000 sq.mi. (excluding Ontario) of water surface, are a series of great retarding basins—absorbing floods. The great storm of March, 1913, and its aftermath, which devasted the Miami Valley, raised Lake Erie little more than a foot. When Lake Erie is at an elevation of 573.0 ft. above sea level, the outflow in the Niagara River is 218,460 cu.ft. per sec.; and the volume of flow is 22,000 cu.ft. per sec. less for a foot lower lake surface. At the head of the Niagara River the outflow passes through a natural sluiceway 1,800 ft. wide and 18 ft. deep at fair stages. (Fig. 2.)

With the mass of adequate physical data available, the determination of the supply tributary to Lake Erie for any month is substantially accurate, and mean values are precise. The elements of supply are: inflow through St. Clair River, run-off from the St. Clair-Erie watersheds, precipitation on the lake surface and evaporation from the lake surface. While the supply itself as a resultant is definitely known, no one element—precipitation, run-off or evaporation—is segregated. The supply only as an algebraic sum needs to be used. This fact simplifies the problem. In the analyses made to determine the possibilities of the betterment of Lake Erie levels, the actual supply was computed for each month over two periods of ten years each, 1893 to 1902 and 1907 to 1916. Then this supply was budgeted by modifying the rates and times of discharge through the Niagara River. This gave a new series of lake level elevations, always on a higher plane. And these new surface levels show the betterment of drafts which would have prevailed had regulation been in effect.

The accompanying tabulation presents in compact form the results of the trial budgeting of the two ten-year periods selected for illustrative purposes.

COMPOSITE RESULTS OF TWO TEN-YEAR AVERAGES OF GREAT LAKE REGIMEN

Month	Erie Elevations, Feet		Gain by Control		Supply Outflow Thousands of Cubic Feet			Effect of Control	
	Controlled	Free	Feet	Inches	Controlled	Free	Gain	Loss
a	b	c	d	e	f	g	h	k	l
Decade 1893-1902—Low Supply									
January	572.23	570.86	1.37	16½	163	195	170	25	..
February	2.02	0.79	1.23	14¾	171	187	165	22	..
March	2.03	0.96	1.07	13	214	196	178	18	..
April	2.24	1.42	0.82	10	229	201	187	14	..
May	2.57	1.73	0.84	10	221	175	194	..	19
June	2.90	1.92	0.98	11¾	206	180	198	..	18
July	3.02	1.89	1.13	13½	187	182	197	..	15
August	2.99	1.76	1.23	14¾	171	182	194	..	12
September	2.83	1.48	1.35	16¼	157	181	188	..	7
October	2.60	1.18	1.42	17	154	180	182	..	2
November	2.40	0.98	1.42	17	164	180	178	2	..
December	572.36	570.92	1.44	17¼	174	167	176	..	9
Means	572.52	571.33	1.19	14¼	184	184	184	7	7
Range April-December	0.78	1.00	....	....	....	....	....	..	..
Decade 1907-1916—Normal Supply									
January	572.60	571.60	1.00	12	185	203	185	18	..
February	2.47	1.55	0.92	11	184	197	182	15	..
March	2.53	1.64	0.89	10¾	235	207	192	15	..
April	2.85	2.27	0.58	7	260	214	206	8	..
May	3.28	2.64	0.64	7¾	240	193	213	..	20
June	3.56	2.78	0.78	9¼	217	200	217	..	17
July	3.65	2.66	0.99	12	197	196	214	..	18
August	3.58	2.48	1.10	13¼	184	200	210	..	10
September	3.38	2.20	1.18	14¼	173	201	203	..	2
October	3.08	1.93	1.15	13¾	162	202	198	4	..
November	2.74	1.57	1.17	14	165	202	190	2	..
December	572.60	571.44	1.16	14	184	176	187	..	9
Means	573.03	572.06	0.97	11¾	199	199+	200—	5	6
Range April-December	1.05	1.34	....	....	....	....	....	....	....

In all the values used it has been assumed that Chicago had been continuously diverting 10,000 cu. ft. per sec.

In the low-supply decade the gain by control in drafts during the season of navigation is 14 in.; for the low-water year, 1895, 15 in.; and for November, 1895, 20 in. This raising of Lake Erie to a higher surface level is transmitted in part through the Detroit River to Lake St. Clair, through the St. Clair River to Lake Huron, through the St. Marys River to the ship locks at Sault Ste. Marie; and through the Straits of Mackinac to Lake Michigan and Chicago—a back-water reach of 900 miles. It was this magnificent axial distance and the radiation of benefits into every bay, inlet and harbor of these wide lakes that impressed the editor of 1895. Lake St. Clair's surface is 3.2 ft. above that of Lake Erie, and 5.6 ft. below that of Lakes Michigan and Huron, with deep connecting river channels favorable for back-water transmission. In passing, it should be observed that a rise created in a down-stream terminal basin, is transmitted by back-water to an upper basin in a percentage which is not a function of the length of the connecting channel, but of the initial difference in elevation of the basins and of the depth of connecting river. The name Detroit is the French for strait. The back-water transmission through this strait-like leisurely-flowing river has a value of 75 per cent.

The trial results shown by the table indicates that by better budgeting the mean plane of Lake Erie may be maintained 16 in. above the plane resulting after a diversion of 10,000 cu.ft. per sec. at Chicago. This will mean an average of 10 in. better drafts than prevailed in a state of nature. A rise of 16 in. in Lake Erie will raise Lake St. Clair 12 in., and that will completely compensate Lakes Michigan and Huron and the St. Clair and St. Marys River for a diversion of 10,000 cu.ft. per sec. at Chicago.

The Great Lakes have been treated thus far as the right-of-way of a great transportation system with an annual traffic approximating 100 billion ton-miles. But two other interests are involved in the Niagara River flow and its artificial manipulation. A treaty exists with Great Britain to protect Niagara Falls, as one of the great scenic assets of the world, against depletion. Restriction of the river flow to maintain Lake Erie levels might violate the spirit of this treaty. Regulating works must be elastic enough to provide mill-pond water in large quantities during certain daylight hours for power uses, so that the natural river flow may pass over the Cataracts.

The fall in the Niagara River from the head of the Cataract Rapids to the foot of the Lower Rapids at Queenston and Lewiston is 316 ft., and the normal flow nearly 200,000 cu.ft. per sec. This means, under the high efficiencies obtained there, a potential six-million electrical horsepower. The treaty limits the diversion for power purposes to 55,500 cu.ft. per sec.—with a potential of 1⅞ million electrical horsepower. Regulation must not only not impair this power, but must serve to better its conditions. Two elements enter from this consideration: greater uniformity of flow, and a more liberal volume than nature provided in the ice-complicated months of January, February and March. It will be seen by reference to Column k of the table, that in such a low-supply period as the earlier decade illustrated, control adds nearly 22,000 cu.ft. per sec. to the volume of winter flow to offset the 10,000 abstracted at Chicago. Finally control must keep vividly in mind the well-being of Lake Ontario and the St. Lawrence.

The instrumentalities, the regulating works, through which control of the river flow may be effected are important. The works designed by the Deep Waterways Commission of 1895 (of which Alfred Noble, George Y. Wisner and Col. C. W. Raymond were members) would serve all the functions of control enumerated in this paper. These works consisted of a battery of 13 massive counterpoised Stoney gates with overhead trusses. The sluiceways were each 80 ft. wide, with total waterway length of 1,040 ft. The midstream sluiceway system was flanked by fixed weirs reaching to the river banks. The depth of water over these weirs would vary from 4 to 7 ft. The works were about a mile upstream from the location now proposed by the writer. These works during construction and operation would have been exposed to heavy wave action in Lake Erie storms. They would have blocked open-river navigation down the river. Perhaps the most serious objection to the building of these works was the fear of the people of Buffalo that they would serve to create ice jams.

The writer in the selection of a site for works in the narrowest section at the head of the river, retreated far enough downstream to escape heavy wave action, but entered a stretch with a stiff current as an obstacle. This site is the reach at the head of the Niagara River opposite and above Fort Erie, Ontario. (Fig. 2.) It is a narrow constricted throat which serves as the natural regulating sluiceway which has created Lake Erie, and determined its elevations and outflow. The river is but 1,800 ft. wide here and 18 ft. deep. The bottom is of bedrock—Niagara limestone. While it is the downbound channel for light-draft vessels, its current is sufficiently swift to deter upbound travel. It is flanked by the Black Rock canal, with ship lock, for deep-draft navigation passing to and from the lower river docks. Any acceleration of current velocities will not scour the bottom, will not work any large inconvenience to vessel interests, or insurmountable damage to riparian owners. Engineering works constructed here will be founded on solid rock foundations; and the compactness of the cross-sectional area insures a corresponding compactness of regulating devices. Perhaps it is judicious for engineers in the modification of outflow conditions to take advantage of the very same river reach which geologic forces have fashioned for natural outflow control. Artificial works then serve simply to supplement natural works. The regulating gates will occupy 800 ft. of the river width. During periods of fully-closed gates, the west 1,000 ft. of the river will have the natural swift current velocity increased about 50 per cent. This width of the river will always be open for free vessel passage with relatively little impairment of drafts. The gates will not be exposed to heavy wave action.

Where the outflow of a river is through two natural sluiceways or channels with an island between, the problem of regulation is relatively simple. In the case of the Niagara River in the section chosen, the outflow is in a single sluiceway. By artificial means this single sluiceway must be divided into two sluiceways. Then reduced flow may be brought about in one sluiceway, while the other runs free. The division of the throat of the Niagara River, as proposed, is effected by the construction of a submerged division wall of rock-filled reinforced-concrete cribs. This wall follows the current direction in its alignment, is about 4,000 ft. long,

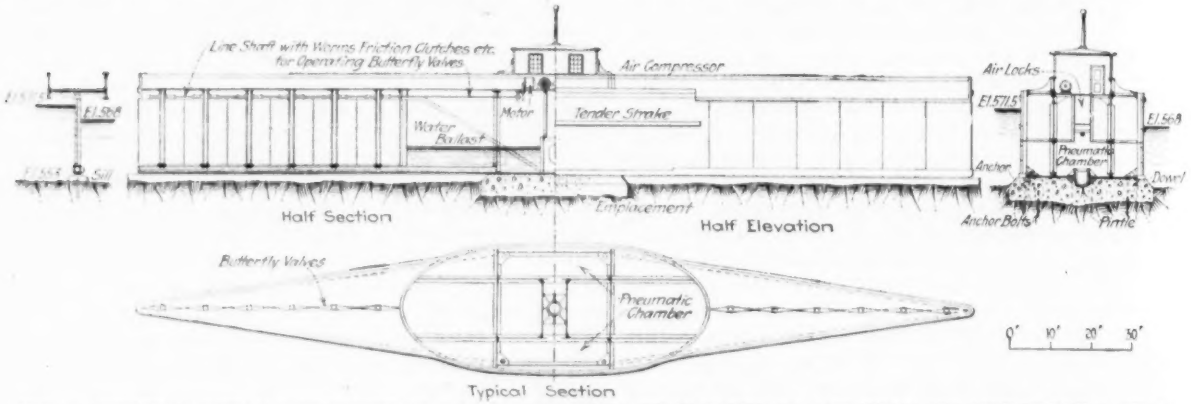


FIG. 4. GENERAL DETAILS OF BUTTERFLY DAM SECTION TO BE FLOATED TO AND FROM ITS SITE TWICE A YEAR

and lies about 800 ft. out from the American river edge in the narrow section.

It forms, with its movable shutter-dam, a partition which permits damming the water on one side when throttling of the outflow is desirable. During the winter season, and in April when ice is running, the shutters hang reversed, well towards bottom; and the wall itself, with its top four to six feet below the water surface, permits such lateral movement of the floating ice as may be needed. (Fig. 3.) The cribs will be built on ways, and floated into place by the aid of pontoons. The sections are interlocking. The filling will be as far as practicable compact so as to minimize cross-leakage on the maximum head due to a difference in level of the two sluiceways of 3½ ft.

The functions of the regulating gates have been indicated. A rigid condition has been assumed as imposed. No piers may be placed in the river which will endanger creating an ice jam. This means that no piers at all reaching to, near or above the water surface are permissible. This condition immediately eliminates consideration of any battery of gates suspended from overhead bridge platforms. Two types of structures are therefore indicated as conforming to this condition: first, movable weirs which when lowered retreat into submerged subterranean pits, or else collapse and lie flat on the bottom; second, removable gates which are floated into place in May and are removed at the end of December. The inaccessibility of the moving parts of gates or weirs fixed to the bottom or sunk in pits, and the probability of sediment interference,

eliminates the first type. The alternative type, the removable gate is recommended in this report, although in a structure of this magnitude and importance a departure from exact precedents is involved.

Precedents are many of great structures floated into place. The original 250-ft. trusses of the International Bridge, just below this proposed structure, were floated to their piers on scows—back in the seventies. The sections of the Detroit River tunnel were built in a shipyard, floated to the tunnel site, sunk crosswise of the current, and the several sections locked together. The floating concrete caissons used at Milwaukee under the direction of Col. Wm. V. Judson are familiar examples of the best practice in pier and breakwater construction. The only departure from ordinary practice recommended by me in this report consists in removing the structure at the end of the year, and floating it back to a safe winter berth.

Obviously, releasing the gates is simpler than placing them. Structures of less magnitude do have this cycle of placing and removal and replacing. A lightship and a gas buoy are portable lighthouses, set out in the spring to be taken back to the dock in December and set out again in April. Floating drydock gates are not unknown, and great floating drydocks themselves are in these days built in shipyards and towed from port to port. The drydock may come to the battleship, instead of the battleship going to the drydock. The gates proposed for the Niagara regulation, are specially designed for annual placing and releasing. A vessel hull forms a permanent part of the structure; and locking to the replacement and releasing are made easy by providing inclosed pneumatic chambers where the manipulations may be readily carried out dry.

The simplicity of the gate and the absence of any inaccessible mechanisms, guarantee its successful use. It has been named the Multiple Butterfly Gate, because each of the units is made up of twelve butterfly valve panels, occupying about 120 ft. of the 202-ft. gate. The hull, containing the buoyancy and pneumatic chambers and housing the valve-operating motor and air compressor, is about 80 ft. fore-and-aft with 21-ft. overall beam amidship. Fig. 4 illustrates this gate in sufficient detail to permit touching only lightly on its features here. Four units or sections of multiple gates make up the cross-stream works. Each when in place for throttling the flow lies at right angles to the river axis, and is locked by massive bolts to a flat-topped 36-ft. square reinforced-concrete emplacement footed in, and heavily bolted to, the Niagara bed limestone. The emplacement floor is about 2 ft. above the level of the clean rock bottom. Where hull and emplacement meet, contact is made elastic by timber cushioning on the hull bottom. In the May-time placing of the gates, each section will be brought down the river from the head of the Black Rock Canal by two tugs and definitely located over the emplacement by the aid of intersecting ranges, using side and head anchor lines for exact centering. The gate is then settled down on the emplacement by flooding the water-ballast chambers; the pivot is entered, and the gate is then self-operating for its rotary swing to a cross-current position, and the locking to the four corner anchor bolts.

The obvious use of the butterfly valves in the current operation of this maneuver needs no detailing. While swinging on the center pivot, the gate has been designed as excessively safe against any current forces tending to slide it off the emplacement or to overturn it. When in its fixed cross-stream position, with ballast tanks full, the gate is designed amply safe as a gravity dam for a 5-ft. head without tension anchorage to the emplacement. But in addition to its gravity stability its four corner anchorages give it an additional safety against overturning, as well as caring for unbalanced forces tending to rotate the gate on its pivot. When all anchorages are fast, the gate is abundantly safe against rotation with all butterfly valves open on one arm, and all closed on the other.

The design has fully considered torsional stiffness under all conditions; and when drydocking for painting or repairs, the gate may safely rest on keel blocks placed near the bow and stern. Butterfly valves and air compressors, for ejecting water from ballast tanks and pneumatic chambers, are electrically operated. The bringing of a gate to its emplacement and pivoting it, present no difficulties of navigation or of mechanism. It will be as easy and less hazardous than bringing an ocean liner into the port of New York and docking it. Two tugs and their crews, with the gate-operating gang, will place one gate in half a day. The reverse operation of releasing the gate in December, and towing it downstream to its winter slip, will be easier than the spring operation. Regarded as a vessel floating free, the gate is designed to have plenty of stability against tipping over. For its two days of navigation a year, each gate will have such facilities as are needed, and mooring and wintering will be made easy and safe.

When in position as gates, the four will form a continuous deck or platform reaching from a shore abutment for a distance of 810 ft. to the division wall. With all valves closed the throttling value will be 40,000 cu.ft. per sec.; and with all valves open, the obstructive value will not exceed 10,000 cu.ft. per sec. This permits a release of 30,000 cu. ft. per sec., when desirable, from day to day.

It is obvious that regulating structures of the kind recommended in this report, are capable of much variation in detail while embodying the same principles. The vital principles are: The removable feature of the cross-stream gate structure—to avoid ice obstruction; the easy operation of valves to release 30,000 cu.ft. per sec. at any time; and the division wall which parallels the current instead of being placed across the current—again to avoid ice obstruction. Adhering to these principles the wall and dam may differ in detail or form.

In estimating the cost of these regulating works the difficulties have been fully considered of those portions which need to be constructed or sunk in the swift current of this river section—such as the emplacements, the cross-sill and the division wall. On account of high labor and material costs all unit prices have been placed high. The estimated cost is $1,224,000. This cost does not include interest during construction or possible claims for damage by riparian property owners along the reach of the river front where the current velocity is increased. The cost of operation and maintenance, not including interest on investment or sinking fund, will be approximately $40,000 a year.

The report on the Niagara River Regulation, which this article epitomizes, was made to George M. Wisner, Chief Engineer of the Sanitary District of Chicago. Adolph F. Meyer, Member American Society of Civil Engineers, collaborated in the design of the gates and the division wall.

Mucking With Steam Shovels Speeds Up Tunnel Driving

Rivalry Stimulates Progress as Power Company in California Vies With Contractors in Working Out Speediest Methods

THE Kerckhoff power plant now being built by the San Joaquin Light and Power Co. about 40 miles east of Fresno, Cal., is to supply additional power for which there is urgent and immediate demand in the territory this company serves. In laying out the construction plan, every effort was made to speed up the work. About 3¼ miles of tunnel had to be built between dam and forebay, and as this part of the work would be the limiting factor in the time of completion,

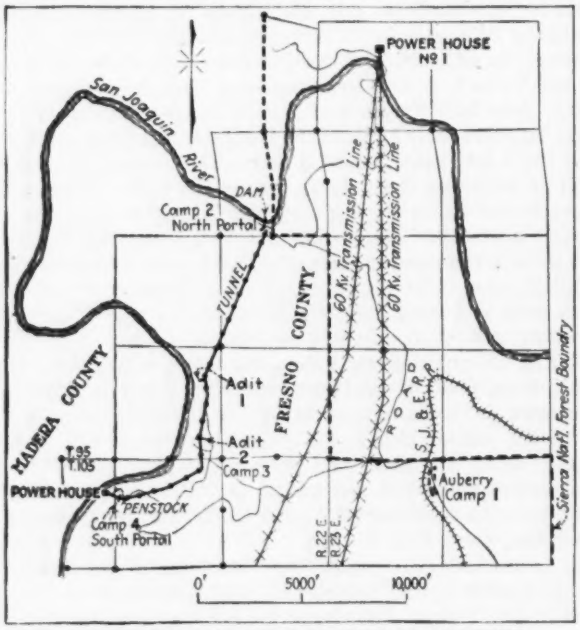


FIG. 1. TUNNEL LINE OF THE KERCKHOFF POWER PROJECT

special study was devoted to the tunnel-driving methods to be employed.

From its upper end, the tunnel line first cuts across a bend in the river on an 8400-ft. tangent that can be driven only from two headings. Thereafter the line follows the valley, and was made accessible by adits at convenient points. A plan for prosecuting the work from a total of five headings was selected, this decision being influenced by the fact that as about 4000 ft. would have to be driven from each heading of the long tunnel there would be no advantage in completing other sections much earlier.

To gain any benefit there might be in trying out different methods of handling the work, to bring in organizations of men experienced in tunneling, and to foster a spirit of rivalry between crews at different points, contracts were let to three experienced tunnel drivers. One of the contractors works two headings. The fifth heading, which is one end of the long tangent, is being driven by company forces. The tunnel is to handle a flow of about 1600 sec.-ft., but it was thought worth while to make the cross-section somewhat larger than required by this capacity, in order to permit steam shovels to work at the headings. Accordingly, a section of 17 x 17 ft. was adopted, and steam shovels have been used for handling muck in all the headings.

Great rivalry has been developed between the tunnelmen by the posting in each camp at the first of each week of an announcement of the previous week's progress at each heading. Four methods of driving have been employed in the five headings.

At the north portal, worked by company forces, the top-headings-and-bench system is used. The heading, 8 ft. high, is carried about 7 ft. ahead of the bench. As soon as a round of shots has been fired, the steam-shovel crew begins loading out the muck. At the same time, the machine men and chuck tenders start on top of the muck pile, shoveling back the material remaining on the bench. By carrying a short bench, only a small amount of hand mucking is necessary. Thus, drilling in the face proceeds while the steam shovel handles the muck. Under this plan, three drilling crews are maintained, so that three 8-hour shifts can be worked. Shovel and train crews are on a "call-shift" basis, as it is not possible to lay down a definite daily program by which drilling and shooting can be carried out. In this heading the formation is a very blocky gneiss with a vertical grain. About 36 holes are placed in the face and 12 holes in the bench. The holes are 13 to 15 ft. deep, and the average round breaks 10 to 11 ft. A maximum progress of 12 ft. per day has been made, but the average rate has been only 9 ft. as progress has been materially affected by the large quantities of water encountered. In this heading the tunnel is being driven downgrade.

The same method as that just described is being used by contractor De Lucca at the south portal. The maximum progress here has been 86 ft. per week. The vertical-face as well as the heading-and-bench method is employed by Robinson & Tinkler, contractors, at adit 2, where two headings are being advanced. The best progress here has been 12 ft. per day.

At adit 1 contractor Iverson is using a drill carriage equipped with nine drills, working the entire face of the heading. The drill carriage is a car carrying a 17-ft. vertical column with a jack at each end and four crossbars on which the drills are mounted. With this equipment the method of operation is to drill and muck alternately, the mucking being completed before the drills go back to the heading. Under this plan both drilling and mucking crews have to be on a call-shift basis. At this heading the formation is a very hard, coarse-grained blue granite, absolutely seamless. It requires about 75 to 80 holes for each round and about 25 per cent more powder than the work at the north portal. The maximum progress at this heading has been 104 ft. per week. Results with this machine have been such that the company is building another one of similar design to try out at the heading being driven by company forces.

Under the terms of agreement with the contractors, the company supplies air, power, powder, drill steel and large equipment. The contractors furnish the small tools. Payment is made on a yardage basis, no overbreak being allowed. The section of the tunnel nets 10 cu.yd. per lin.ft.; the overbreak has ranged from 8 to 15 per cent. Labor and powder costs, according to the records on the heading driven by the company, have totaled about $43 per foot.

The following tabulation gives an analysis of the

time consumed by the various operations at the heading, as conducted with the first drill carriage:

AVERAGE FOR FIFTEEN DAYS, OCT. 1-15, 1919

Footage	130 ft.
Rounds drilled and mucked	14
Drills used per round	8.7
Holes drilled	86
Holes drilled, average depth	10.4 ft.
Holes drilled per machine	9.7
Powder used per foot of tunnel	79 lb.
Moving in and setting up	1¾ hr.
Drilling time, per round	5⅛ hr.
Shooting time, per round	1⅜ hr.
Drilling one hole	0½ hr.
Mucking	10 hr.

The shovels used for mucking are operated by compressed air from the drill line. They are all equipped with specially constructed booms, 13 ft. long. With these booms the bucket can be swung around at right

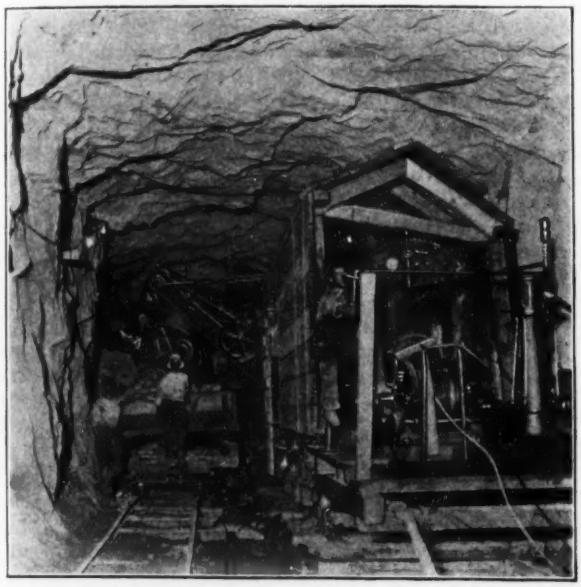


FIG. 2. HANDLING MUCK AT THE FACE BY AIR-OPERATED SHOVEL

angles without striking the far wall, so long as the shovel body is kept close to one side of the tunnel. The shovel is run in on a standard-gage track, and when it is in position for mucking a tunnel jack on the front end and on the side away from the wall is used to give the shovel stability. About 250 ft. of the broad-gage track is left in place behind the shovel so it can move back from the face when shots are to be fired.

The shovel uses a 21-cu.ft. bucket. Ordinarily a 150-yd. muck pile, such as is pulled down usually by a round of shots, is cleaned up within eight hours. Practically no bulldozing has been necessary. When pieces are found too large to be handled by the shovel in the ordinary way, a chain is slipped around the rock and looped over the teeth of the bucket.

At present, while the headings have not been advanced far from the portals, one muck car at a time is filled and hauled out. When the advance has been sufficient to warrant it, a siding will be put in, so that after a car is loaded it can be put in the clear and another empty put beside the shovel, with minimum delay.

On the whole, the company expresses entire satisfaction with the record made by the shovels. They have greatly reduced the number of muckers required, which is a particularly important advantage just now, and are doing the work, it is stated, in less time than would have been possible by hand methods.

The work is being carried out under the direction of R. C. Starr, construction engineer for the San Joaquin Light & Power Co., with W. A. Whitmire as general superintendent, E. H. Warner resident engineer and E. L. Fox general tunnel foreman.

Longest Spans of American Bridges

ADVANCE in bridge construction as represented by length of span of the various distinct types of bridge is recorded by Prof. H. S. Jacoby, in the *Cornell Civil Engineer*, by means of the table reproduced herewith. Prof. Jacoby points out, with reference to the dates given in the last column, that in nearly three-fourths of the classes which he lists an increase in maximum span length occurred during the present decade, most of them during the second half of the decade; and that only two bridges in the list date back of 1900.

In simple-truss spans marked advance has been made in both pin-connected and riveted types in recent years. Up to 1906 the longest pin-connected span was 546½ ft. (Louisville). This was exceeded by the Elizabethtown (Ohio) bridge of 586 ft., followed six years later by the 668-ft. span of the Municipal Bridge in St. Louis and in 1917 by the 720-ft. span of the Metropolis bridge. For riveted trusses the longest simple-truss span up to 1907 was 300 ft. 10 in. In 1908 the 412 ft. 8 in. span of the Canadian Pacific bridge over the French River was completed, and in 1911 the 425 ft. 6½ in. span of the Fratt bridge across the Missouri River in Kansas City. The long span of the Pennsylvania bridge at Louisville, 643 ft. 10½ in., represents an increase of 50 per cent in a single step.

The completion of three notable continuous truss bridges less than three years ago is a remarkable feature of bridge progress. Besides the Sciotoville bridge of two 775-ft. spans, given in the table, there are the Nelson River bridge of the Hudson Bay Ry. (400-ft. span) and the Allegheny River bridge of the Bessemer & Lake Erie R.R. (maximum span 520 ft. ½ in.).

Supplementing the record of concrete arches, represented by the Monroe St. and the Larmer Ave. bridges, noted in the table, the 400-ft. span of the Franklin Ave. bridge at Minneapolis, crossing the Mississippi River, is to be kept in mind. This bridge is now under construction.

No.	Class of Bridge	Span Ft.	Span In.	Location	Date of Completion
1	Simple plate-girder	130	6½	Grand Crossing, Ill., Nickel Plate R.R.	1916
2	Steel viaduct	100	0	Lethbridge, Alberta, Can. Pacific Ry.	1909
3	Simple truss, riveted	643	10½	Louisville, Ky., Pennsylvania Lines	1919
4	Simple truss, pin	720	0	Metropolis, Ill., C. B. & Q. Ry. and N. C. & St. L. Ry.	1917
5	Swing, plate-girder	236	0	Lachine Canal, Montreal, Can. Pac. Ry.	1915
6	Swing, truss	521	0	Portland, Ore., Northern Pac. Ry.	1908
7	Vertical lift	296	0	N. Mondak, Mon., Gt. Nor. Ry.	1914
8	Vertical lift, floor only	428	0	Kansas City, Mo., Terminal R. R.	1911
9	Bascule, single leaf	260	0	Chicago, St. Charles Air Line Ry.	1919
10	Bascule, double leaf	336	0	Sault Ste. Marie, Can. Pac. Ry.	1914
11	Serial ferry	393	9	Duluth, Minn., over Ship Channel	1905
12	Continuous truss	775	0	Sciotoville, O., Chesapeake & Ohio Northern Ry.	1917
13	Cantilever	1800	0	Quebec, Natl. Transcontinental Ry.	1917
14	Suspension	1600	0	New York, Williamsburgh Bridge	1904
15	Steel arch, three-hinged	592	0	Needles, Calif., Colorado River	1916
16	Steel arch, two-hinged	977	6	Hell Gate, N. Y. City., N. Y. Connecting Ry.	1917
17	Steel arch, no-hinge	519	9½	St. Louis, Pennsylvania Lines	1874
18	Stone arch	220	0	Cabin John Bridge, near Washington	1864
19	Plain concrete arch	281	0	Monroe St., Spokane, Wash.	1911
20	Reinforced-concrete arch	300	4½	Larimer Ave., Pittsburgh, Pa.	1912
21	Concrete viaduct	180	0	Nicholson, Penn., Lackawanna	1915

Loading Test of 18-ft. Circular Concrete Grain Bin

Bins Separated by Tie-Walls Investigated as to Behavior Under Outside Pressure from Grain in Interstices

By P. J. Hansen

Structural and Chief Engineer, Burrell Engineering & Construction Co., Chicago

UNUSUAL load conditions in grain elevators having the interstitial spaces nearly as large as the circular bins led to tests to indicate the action of the circular walls under such loads. In general, the circular or cylindrical bins are built in clusters having contiguous walls so that the walls receive lateral pressure on both sides, the pressure on the convex side being about 25

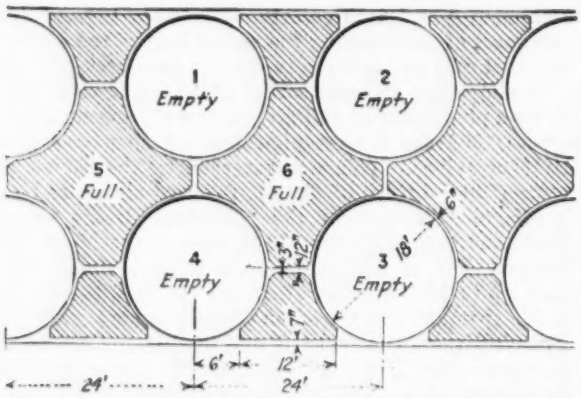


FIG. 1. TYPICAL ARRANGEMENT OF GRAIN ELEVATOR WITH SPREAD SYSTEM OF BINS

per cent of that on the concave side. In several elevators designed and built by the Burrell Engineering & Construction Co., Chicago, the spread type of bins has been used, in which the cylindrical walls are not in contact with each other but are connected by tie-walls at the quarter points of the circles, as shown in Fig. 1. With this arrangement the interstices have about the same capacity as the bins, while the flat exterior wall is considered to give a better appearance than the corrugated wall formed by a series of bins.

The spread type of construction was adopted for an elevator built by the Burrell company in 1919 at Minneapolis, for the Banner Grain Co. This design led to a discussion as to what would take the thrust of the quarter-circle arch when the bins 1, 2, 3 and 4, in Fig. 1, are empty and the compartments 5 and 6 are full. The bins were 18 ft. in diameter and 80 ft. high. Lateral pressure from the grain would be approximately 30 times the diameter, or 540 lb. per sq.ft. on the concave side. On the convex side this pressure would be only 410 lb., for although the compartment has a greater capacity it has also a greater perimeter than the circular bin.

The contention was that in the absence of tests it was unknown what a tank of this diameter would stand with a load on its convex side, and that the tie-walls were insufficient as abutments. While calculations showed that the walls, 6 in. thick, were ample in strength both as a quarter and a semi-circular arch, the writer proposed to build a test tank, or rather a ring, to determine as far as possible what the breaking load would be. This ring, 4 ft. high, was made a replica of the tanks; 18 ft. inside diameter, 6-in. wall, reinforced with hoops of ⅝-in. corrugated round rods spaced 8 in. on centers. In addition to the hoop reinforcement seven 1-in. plain round rods, which in actual construction are the jack rods used to raise the slip forms, were placed vertically about 8 ft. apart on the center of the wall, the hoops being on the outside or very nearly 2¼ in. from the convex side of the ring. The 1:2:4 mix consisted of portland cement, torpedo sand and gravel. The ring was built at the site of the operation under the supervision of an inspector of the building department.

The ring was two months old when tested. Two weeks before the test the ring had been raised from the position in which it was poured and lowered on its side into a pit, as shown in Fig. 2. The ring had a flat side on the exterior for a distance of 12 ft., a condition that afforded an excellent base and a bearing area of 48 sq.ft. At the crown of the ring was formed a contact 6 in. wide and 6 in. high with 6-in. fillets. This contact also occurred on the sides at the quarter point of the circle and provided a means of relieving the lower half of the ring when the upper half was loaded. For this purpose a wood box frame was constructed and tightly wedged under the contacts, but not braced to the sides of the pit, for the reason that in the opinion of the writer the thrust of the arch effect of the load was negligible.

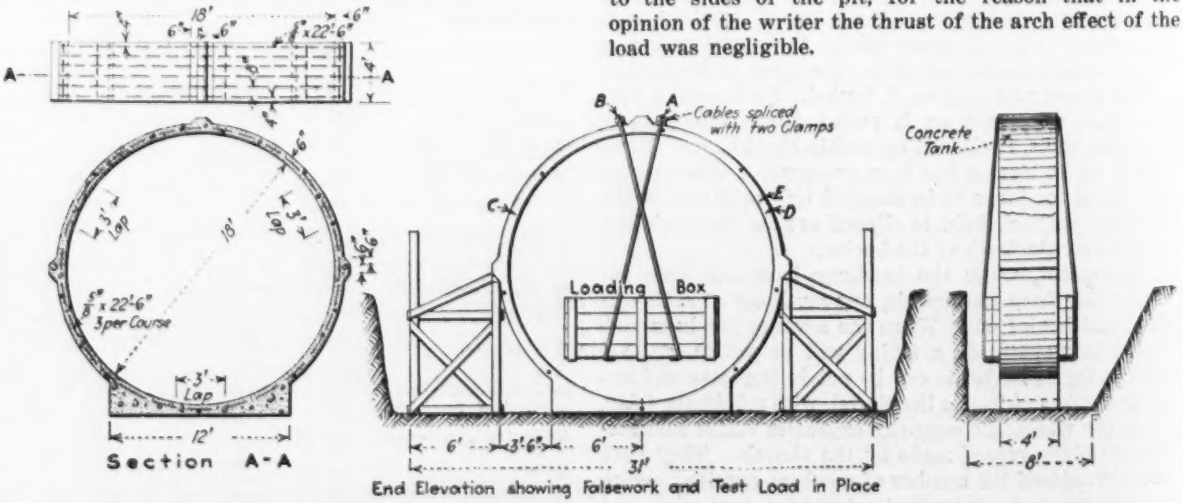


FIG. 2. RING REPRESENTING GRAIN BIN IS TESTED TO DESTRUCTION

Originally it was proposed to load the upper half of the ring as a semi-circular arch with a uniform load of 550 lb. per square foot. As this was found impracticable, a concentrated load was applied by means of a wood box 6 x 10 ft. and 4 ft. high, weighing one ton and having a capacity of 8 cu.yd. of gravel, or 12 tons, this being suspended by ⅜-in. wire cables crossed at the crown of the ring to prevent slipping, as shown in Fig. 2.

Before any gravel was shovelled into the box, measurements showed a vertical deflection of ⅞-in. and a total horizontal deflection of ⅜ in. due to the dead load. When the load reached 1½ tons, or one-eighth full load, a crack developed on the concave face of the crown directly under cable A and parallel with it, where a 1-in. jack rod had been placed within an inch of that face instead of in the middle of the wall as is done in actual construction. Corresponding cracks appeared on the reverse face at points D, E and C; or very nearly the third point of the quarter circle nearest the horizontal axis.

At half the load, or six tons of gravel, the vertical deflection was 1¼ in. and the total horizontal deflection ⅞ in. At this stage of the test the concrete spalled off under the rod at A and the crack widened to 1/16 in. and extended the full depth of the ring, or 4 ft. in length. Fine hair cracks appeared on the cross-section of the A-D quarter circle, showing that the strain was that of a cantilever with the load A at the end. It was apparent that the test would not be a fair one as far as the ring was concerned, the unsymmetrical deformation showing the effect of the unsymmetrical section due to the 1 in. jack rod under load A.

Fig. 3 is evidence of this. The section of the quarter circle B under the load was perfect, no crack being visible at cable B, where the wall was full 6 in. thick. But at A the jack rod served to reduce the section to 3¾ in. and the ring broke and dropped to the ground at ultimate failure due to bending and shear at this point. The failure was sudden and occurred as soon as box was full, the total superimposed load being 13 tons. The initial break was at A and was followed in the order named by breaks at D, C, F and G. There was a momentary pause in the collapse between breaks at F and G, the ring at G acting like a cantilever.

At no time during the test was the observed action of the ring that of an arch. There was no thrust to speak of, the wood support at D was simply pushed over at the collapse, while that at G remained standing. The action was more like that of a hoop and it must be admitted that the result was most satisfactory when due allowance is made for the unusual nature of the load. The test proved that, as some engineers have long contended, vertical reinforcing bars in grain bin walls, except such as are necessary for erection, are more detrimental than beneficial.

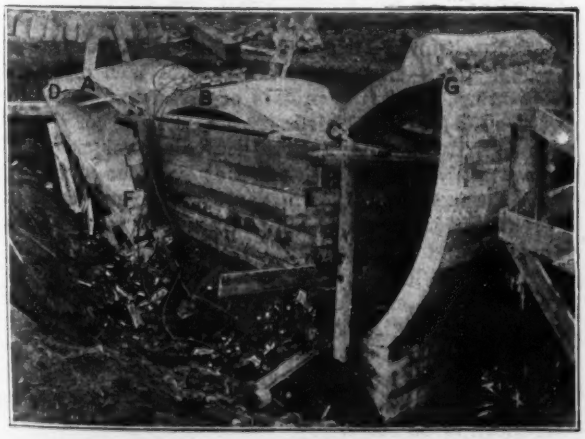
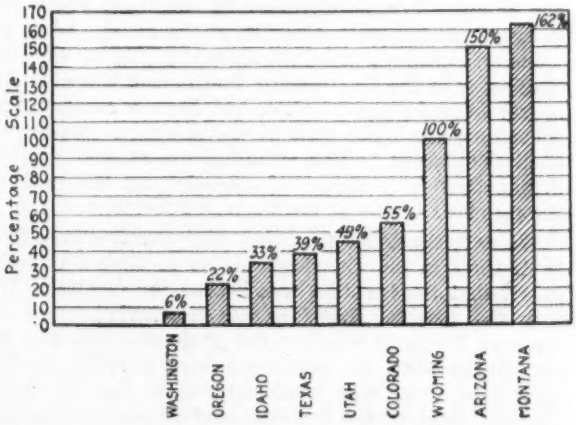


FIG. 3. CONCRETE RING AFTER TEST TO DESTRUCTION

The writer has no hesitancy in drawing the conclusion that a circular tank designed for grain pressure will safely stand the same pressure on the convex side but that such a pressure per square foot should not exceed the pressure on the cancave side. The test was witnessed by engineers representing the Minneapolis Building Department and by G. A. Maney, in charge of the structural testing laboratory of the University of Minnesota.

How Western States Are Adding to Their Agricultural Areas

THE accompanying diagram shows the relative agricultural expansion that has taken place in Western states in the past decade. This comparison is of interest in connection with the proposed Columbia Basin project, a description of which appeared in the *Engineering News-Record* of Oct. 30-Nov. 6, 1919, p. 800, because it shows how far Washington is behind other Western states in which irrigation projects have increased the total cultivated land. The diagram was prepared by J. C. Ralston, consulting engineer, Spokane.



High Concrete Chimney Built on Steel Roof

Two concrete chimneys of an outside diameter of 15 ft. 6 in. at the bottom and 11 ft. at the top and a minimum inside diameter of 10 ft. have been built on the roof of the Montville power station of the Eastern Connecticut Power Co. at Montville, Conn. The chimneys are approximately 160 ft. high above the roof level, which is itself 90 ft. above the ground. Each chimney rests on an annular concrete mat 18 in. thick which is placed on an octagonal frame of steel girders, themselves supported on the main building columns. Steel rods 1¼ in. in diameter, spaced approximately 18 in. on center, anchor the lower sections of the chimneys secure to the girders. The chimneys were designed by the Harry M. Hope Engineering Co. of Boston, Mass, and are described in the January, 1920, number of *Contractors' Atlas*.

Impressions Here and There

The Canadian Engineers Meet

AFTER attending all the meetings and functions incident to the annaul meeting of the American Society of Civil Engineers it was an interesting experience the following week to attend the annual meeting of the Engineering Institute of Canada. One could not help contrast the two—and the contrast favors our Canadian brethren.

The differences are found in two respects; first, the institute has made a great success in developing its branches, and, second, our gathering had a funereal cast, contrasted with the enthusiasm and sociability of the Montreal events.

The fundamental difference between our business meeting and theirs lay in the evidence afforded by the reports of the branches and the Provincial divisions that the society is an active force in every part of the Dominion. That development is but three years old, dating from the reorganization of the society, when its name was changed from the Canadian Society of Civil Engineers to the Engineering Institute of Canada. Its course before reorganization had been a conservative, sober one, much like that of the American Society of Civil Engineers. This resulted in strong protest, culminating in a threat of secession on the part of the members in one of the western Provinces.

We have no doubt that the older conservatives felt, as do those in the American Society of Civil Engineers today, that the institute was headed for disaster. We took the trouble, therefore, of questioning many of those at Montreal whether the profession had lost by the change—and we questioned very particularly the older men, those who would appreciate that the most precious asset of the institute and of its predecessor, the Canadian Society of Civil Engineers, was its prestige, its professional standing. Without exception the answer was that the prestige had not been impaired and that the technical work had not suffered.

We believe that our own conservatives would have been heartened could they have been at Montreal, and measured the new strength that has come from the expansion of activity and interest, which, in turn, are due to the strengthening of the branches and the establishment of Provincial divisional organizations. We were told that before the reorganization the meetings were poorly attended and very stereotyped. The meeting this year was large, the largest in the institute's history (registration, including guests, 650) and more enthusiastic than any meeting of a professional body we have had the privilege of attending. If the Canadian experience is a criterion, the American Society of Civil Engineers will profit much by the strengthening of the sections and of the districts provided in the Development Committee's report.

Incidentally, the Canadians do not include in their branches every member of the society, as is proposed by our Development Committee. Only those are members of branches who reside within 25 miles of a branch headquarters or those at a greater distance who signify their desire to be members of a branch.

The Young Men—Quite in contrast with our experience, too, was the very evident interest and activity of the young men. We could not by lengthy discussion bring out the idea better than by stating that the Toronto Branch last year, out of its *fifteen* meetings, *held two expressly for the younger members*, one of them to give opportunity for the young men to express their views of what the institute could do to improve the status of the engineering profession in Canada, the other to get their views on the institute's proposed standard registration bill—enough said.

Papers and Entertainments

The Montreal gathering differed from those of the American Society of Civil Engineers also in that, like the other national societies on this side of the international boundary, papers were read. In other words, there were technical as well as business sessions. We have no doubt that all present would agree that the meeting was all the better for it. Their minds met on large technical topics as well as on those professional and general topics which are the natural gist of conversation when engineers come together. In this respect, too, we are to follow our Canadian friends if the Development Committee's report is adopted.

As to the conduct of the meeting as a whole we can well take a leaf from our Canadian friends' book. From the convening of the business meeting on Tuesday morning, to the singing of "God Save the King" at the close of the concert-smoker Thursday night, the proceedings went with a snap that left nothing to be desired. The serious parts of the program were relieved by entertainment, both frequent and varied, resulting in a sustained interest and spirit that are difficult to describe without suspicion of exaggeration. There were luncheons Tuesday and Wednesday noon, a reception and dance Tuesday night, a banquet Wednesday night and the concert-smoker Thursday night.

The last event, the concert-smoker, we might particularly copy. The room was amply large, and, mercy of mercies, chairs were provided, gathered suggestively around tables. By contrast, we are still suffering from flat-foot from standing all evening at the Am. Soc. C. E. smoker. And on the tables were bottled goods that cheered—now banished from these arid states. The entertainers were first-class—both professionals and amateurs—led by Wilkie Bard, the famous English comedian, who was playing in the city at the time. Added to it all was a spirit of fellowship that made the company one—from the contingent of men of French descent who sang the praises of Laval to the last son of McGill or the University of Toronto or Queens who added his voice in the deafening volume of his university yell. We are sure that everyone went away with the feeling that the institute was a very real thing—something that helped him to come close to his brother engineer and to work with him for common objects.

Before we left we fished an invitation to come next year. We do not see how Toronto, where the next annual meeting is likely to be held, can possibly excel the hospitality and enthusiasm of Montreal, but the Toronto men somehow, we will wager, will do it as well. But whatever the program, if the good Lord spares us we mean to be there.

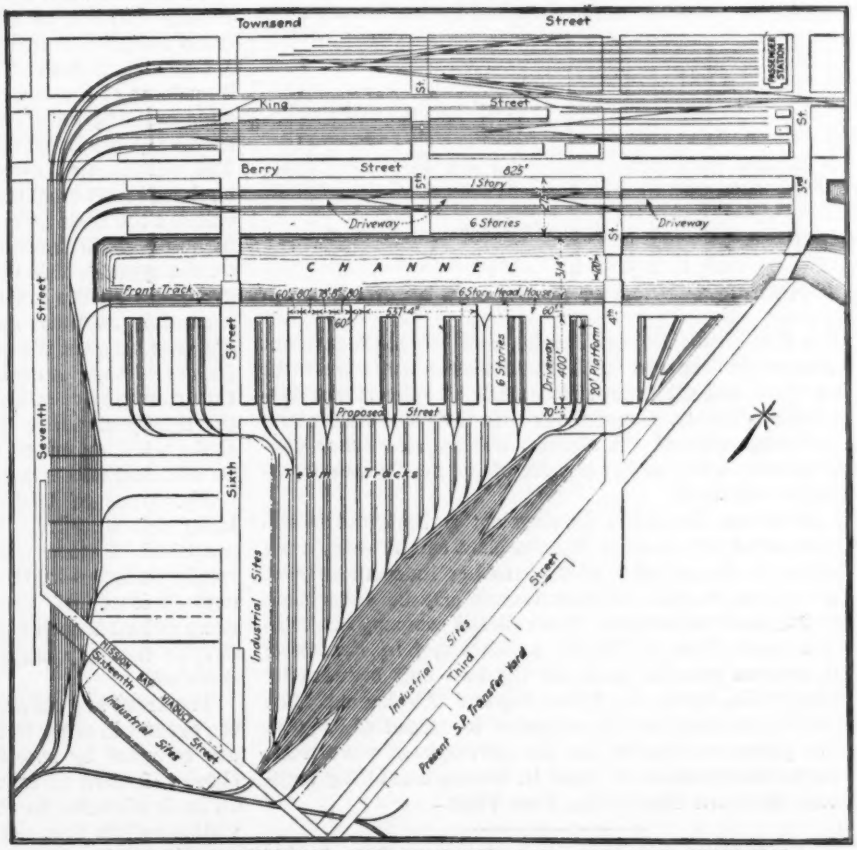
Montreal, Jan. 30, 1919.

New Industrial Development Planned at San Francisco

Southern Pacific Adopts Design for Rail and Deep-Water Terminal With Manufacturing Facilities on Channel Street Property

A PLAN for the extensive development of its Channel St. property at San Francisco, near the site of the present passenger terminal, has been adopted by the Southern Pacific Co. to convert the old channel into a deep-water harbor and to provide a rail terminal with manufacturing and warehouse facilities, in anticipation of the congestion which may follow the rapid growth of the city's industry with the opening of the Panama Canal. It is the present intention to call for bids for constructing the first unit of the development as soon as the detailed plans, now in course of preparation, are completed.

The general plan adopted, which is the result of several years' study of the situation, includes reinforced-concrete warehouses and facilities for light manufacturing, a freight storage yard, transfer platforms and elevators, switching and team tracks, driveways, freight sheds and industrial sites adjacent to the yards. The plant has been designed to operate both as a railroad and a ship terminal, to be used as either, as changes in conditions may require. As shown in the accompanying drawing, the site of the development is adjacent to the existing passenger terminal. With the exception of main-line tracks parallel to Seventh St., the only facilities now existing are those shown north of Berry St. The new development is planned to include all of the other facilities shown south of Berry St.



PLAN FOR INDUSTRIAL SITE COMBINES RAIL AND SHIP TERMINAL

The six-story concrete warehouses, a typical section of which is indicated in the drawing, will be adapted for either storage or light manufacturing on both the north and south sides of the channel. The first floor of each warehouse is to be used as a transfer platform between railroad and ship, and under ordinary conditions will provide enough room for unloading to prevent demurrage of inbound freight cars. It will also be used as a place for the accumulation of freight, to minimize idle time of ships and cars.

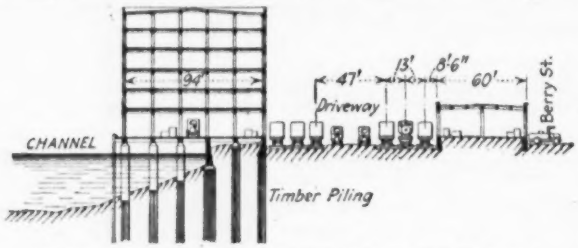
The design for facilities on the north side of the channel was necessarily more complex than on the south side because of restricted area, and the fact that property is very valuable here on account of its proximity to the business center of San Francisco. The additional team-track space provided on the north side, together with the three inbound freight sheds, are intended to relieve the traffic congestion likely to occur nearest the center of business. On the south side of the channel, however, where considerably more area is available, it was practicable to incorporate in the plan the scheme which appeared to be best suited to traffic requirements. Headhouses, 537 ft. x 60 ft., are provided with six-story wings extending 400 ft. toward the south, between which lie alternately driveways and tracks. At the Galveston, Tex., terminal of the Southern Pacific Co. this scheme has proved especially suitable for inbound steamer freight, as cargo can be unloaded from the steamer; classified on the pier, and trucked directly to the cars. The number of available tracks will permit considerable classification of freight, obviating the necessity of providing more extensive classification-yard facilities and simplyfying their operation.

With the facilities offered for the rapid handling of freight, it is the purpose of the plan that a ship can be unloaded as rapidly as stevedores with the aid of modern machinery can perform the work, and then warped into another berth, loaded and sent to sea. It is also the purpose of the plan that freight cars shall be subject to as little delay. However, to provide flexibility of operation, the plan includes large storage yards with ample switching facilities to the warehouses and ships. Since some materials require a longer time to accumulate, and others may have to be stored before distribution, warehouse space is provided. The buildings are arranged for good lighting throughout for light manufacturing as well as storage. Driveways are located to give teams access to all of the facilities. To the south of the warehouses on the south side of the channel a

street 70 ft. wide provides for the ingress of teams to driveways and team tracks for city delivery to and from the terminal.

Unusual Construction Problems

It is expected that unusual construction problems will be encountered in carrying out the development. For example, it is proposed to place a second-story clear balcony about 20 ft. wide for the entire waterfront side of all warehouses for delivery direct by steamship's tackle. The soft mud foundations will probably require very long timber piling and possibly cylinder piers down to mud line. The abutments of the present bascule bridge at Third St. were reinforced by steel struts after



TYPICAL SECTION AT NORTH SIDE OF CHANNEL

the San Francisco earthquake, and when the present channel is deepened to 33 ft. this steel will have to be removed and other provision made to support the concrete abutments. Connections with the front track along the south side of the channel will require heavy construction at two of the corners of the headhouses fronting the channel.

Although the entire development is indicated in the plan, the design is such that the plant can be built in ten or more stages, each unit operating independently of the others, so that additional work may be undertaken as conditions determine. The railroad company has commissioned Bliss & Faville, architects, San Francisco, to prepare detailed plans for the first unit bounded by Fourth St., Berry St., Third St., and the channel. The cost of the first unit is expected to exceed $1,000,000. The plans and studies for the development were made under the direction of John D. Isaacs, consulting engineer Southern Pacific Co., New York.

New Brunswick Timber Surveys and Cruises

Locating and Marking Timber Block Lines—Cruising Parties—Methods for a Four Per Cent Cruise—Timber and Soil Maps

SURVEYS and timber-cruising operations as used in the administration of the New Brunswick forests are based on the system of allotting licenses by "timber blocks," areas of 1000 to 12,000 acres, averaging 4000 acres (about 200 chains square). G. H. Prince, provincial forester, described the methods recently before the Engineering Institute of Canada (see *Journal* of the Institute, October, 1919). The work involves running the block boundaries, then cruising (estimating the timber), and, finally, mapping.

In running the timber block lines, both retracing and the locating of new lines are involved. The law requires the work to be done by qualified Provincial Land Surveyors. Five crews have been employed during the present season, and some 700 miles of line has been run. The lines are being thoroughly blazed, stakes or trees being marked with chainage and block numbers every 20 chains; in addition, posts are set wherever the lines cross portages, streams, lakes, etc., and the posts are marked with their chainage from the nearest corner and proper block numbers. This enables the lumbermen's cruisers as well as the government rangers to locate themselves quickly wherever they encounter a post along a portage, by referring to their plans. All work is being done by compass. It is required that the lines close within a certain limit.

After this, the area is cruised. A cruising party usually consists of about 13 men, made up of chief, camp compiler, 3 cruisers, 3 compassmen, 3 calipermen, 1 teamster, 1 cook. The cruising is done by parties of 6 made up of a compassman, a cruiser and a caliperman. This cruising crew travels from one quarter-mile post across the block 200 chains to the post exactly opposite. The compassman directs the course and acts as head chainman. The caliperman acts as rear chainman and calipers the trees on one side of the chain for a distance of half a chain from it. The cruiser also calipers trees on the opposite side of the chain for the same distance and takes all the notes. No attempt is made to chain accurately on these so-called cruise lines, as the exact distance between the two block lines is known from the former survey. A cruising crew will cross a block twice, thus running five miles of cruise line a day, or recording the timber standing on a strip five miles long and one chain wide, or on 40 acres. The cruise lines are run parallel and 25 chains apart.

The types of timber (hardwood, softwood, burned land) are recorded. The cruiser also notes all topographical features—slopes, brooks, streams, rivers, roads, portages—with description of each. The notes, kept in loose-leaf metal folders, are turned in to the camp compiler each night and are plotted the following day, so that any errors or omissions may be properly detected.

The trees are calipered outside the bark 4½ ft. from the ground in order to avoid the swell of the root. They are recorded by species and diameter, so that a tally sheet will show so many spruce trees 8, 10, 12, 14, 16, 18 in. in diameter on the number of acres calipered. All visible defects that can be observed in the standing tree are allowed for when calipering the tree; hidden defects are covered by a deduction made from the estimate. The contents in board feet is arrived at by a volume table; the average per acre is applied to the total area of the same class of timber land. In this manner four acres out of every hundred are measured; or in other words, the survey is known as a 4% cruise. Check cruises are made after every cruiser twice a month, in addition to the above.

Notes are taken on the soil, rock and slope and other points affecting the possibility of using the land for agriculture. Small shovels are carried and the soil is examined to a depth of at least 12 in., or deeper if necessary to determine the nature of the soil and subsoil.

Two plans or maps are prepared, one showing all survey lines, posts, portages, lakes, etc., and the timber types, and one the soil conditions and topographical features. The plans are being prepared in blocks of 42,000 acres, each plan receiving a distinctive number. When the work is completed there will be 477 of these plans.

A Stone Beam Bridge in China Sixty Years Old

Solid Floor Highway Crossing With Deck of Stone Joists Supported on Thin Piers—Winter Bridges at Fords

By Donald F. McLeod
Tangshan Engineering College, Tangshan, North China

At Tangshan is found a bridge of a succession of stone girders, spanning about 10 ft. The bridge is remarkable both for its floor construction and for its piers. Two photographs of it are reproduced in the accompanying Figs. 1 and 2, and a sketch of its construction is given in Fig. 3. The structure throughout is built of a hard, tough limestone obtained from a nearby quarry.

Each span is supported by seven stone girders 23 x 16 in., laid close side by side, forming virtually a solid

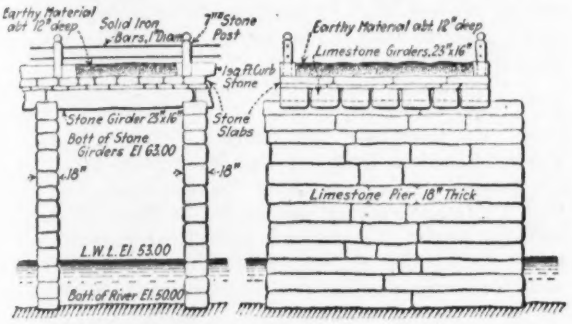


FIG. 3. CONSTRUCTION DETAILS OF CHINESE STONE BEAM BRIDGE

deck. These are covered with transverse stone slabs, and over all is a pavement of earth about 1 ft. deep. Thus there results a solid floor about 3 ft. deep, which gives no rumbling sound whatever under wheeled vehicles.

From an American standpoint the railing is as unusual as the other parts of the bridge. It consists of solid 1-in. round iron bars, passing through holes in stone posts 7 in. square. The splices in these bars are made by flattening each bar to ½-in. thickness, lapping and riveting with a ½-in. rivet. Cemented-up holes about 4 x 6 in. in the posts indicate that the original rails were made of stone.

There is at least equal novelty in the pier construction, whose daring has been fully justified by the long life of the bridge. Each pier consists of only one thickness of stone, being 18 in. thick by 16 ft. long. The upstream end is cut to V shape, but the downstream end is left plain, the stones here projecting irregularly as determined by their jointing and lengths.

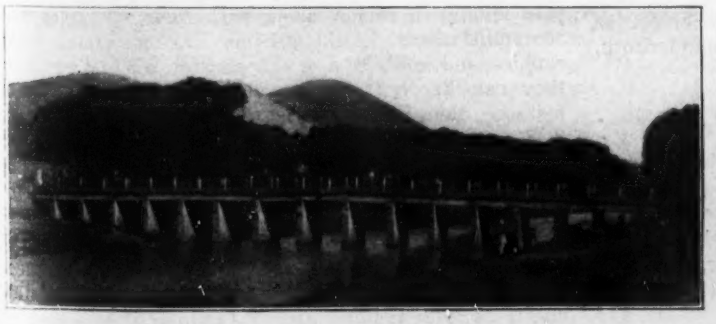
Apparently the piers are not widened out at the bottom in the form of footings, although the bearing pressure at the base is 14 tons per square foot, without allowing for live load on the bridge. There is no indication of rock in the vicinity of the site or probability of its occurrence at the depth to which the piers appear to be carried. One wonders how the Chinese engineer who designed the bridge decided that the soil would stand such high unit loads, and also by what means he decided on the proper length of span to give a minimum total cost for piers and stringers.

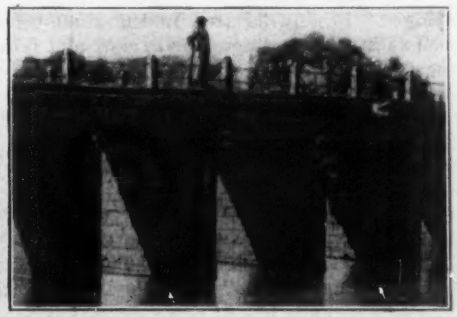
The writer is informed by a South China engineer that the above type of stone bridge is more common in China than the arch type, and that the maximum span for such beam structures is about 20 feet.

There is a pretty high factor of safety in this stone girder construction. With a load of 450 lb. per square foot and a live load of 100 lb., the maximum tension in the bottom of the beams, computed by the ordinary bending formulas, would be about 160 lb. per square inch, representing a factor of safety of nearly 8 on a modulus of rupture of 1200 lb. per square inch. Against shearing there is a very much greater margin.

One might conclude that the excessive number of piers leaves too little waterway. However, the unobstructed waterway amounts to about 470 sq.ft. in cross-section. The drainage area of the little river which flows under the bridge is 310 square miles. Assuming a velocity of flow of 7 to 10 ft. per second, a flood discharge of 40 to 50 cu.ft. per second per square mile would probably overtop the bridge and destroy it. However, there is no record of any flood great enough to fill the waterway, during the period of about 60 years since the bridge was built. The writer's measurements in the vicinity of the bridge for two winters gave a total precipitation, including melted snow, of about 1¼ in. for December to May inclusive, and a total for the 12 months ending Aug. 31, 1919, of only 12½ in. The general conditions as observed by Americans resident here for the past eight years are that the ground is so dry after an autumn and winter practically devoid of moisture that the rains of spring and summer are almost entirely absorbed by the dry ground and thirsty vegetation.

Besides the ornamentation with dragon heads on piers and coping, as shown in the view Fig. 2, the bridge has carved panels in the walls of its approaches, some showing fruits and trees, others with inscriptions in the form of Chinese proverbs. Nearby is a huge





FIGS. 1 AND 2. STONE BEAM BRIDGE AT TANGSHAN, CHINA—10-FT. SPANS SUPPORTED ON 18-IN. CROSS-WALLS

tablet on which are carved the names of those who furnished the funds for the building of the bridge.

A different type of bridge is shown by the view Fig. 4, for the sake of contrast with the preceding. This is typical of bridges built at fords for about three months' winter service.

At many of the fords the bridges for the winter months are built only for pedestrians, wheeled vehicles having to go considerable distances to find bridges. These footbridges have a trestlelike structure, the bents consisting of a round cap with round posts mortised into it. The "floor" consists of a timber at each side, giving two 10-in. roadways about 5 ft. apart. Each timber is continuous over several bents and is connected to the adjoining ones at its ends by loose dove-

FIG. 4. TEMPORARY VEHICLE BRIDGE AT A FORD IN NORTH CHINA—FLOOR MADE OF SORGHUM STALKS

tail joints which will allow vertical motion. Often as the pedestrian approaches the end of the timber it suddenly sinks under him several inches. The Chinese, often carrying heavy loads, walk unconcernedly over these narrow, vibrating paths, when the penalty of slipping on the frosty or icy wood would be a 10-ft. plunge into deep, ice-incrusted water.

In the case of the vehicle bridge shown by Fig. 4, each bent consists of a round cap supported on a three-pile "dolphin" at each end, the dolphins being held together by sorghum stalks used as ropes. Sorghum stalks are largely used as a building material in North China; they have no sweet juice like the American variety, but furnish a cereal largely used by the Chinese. The flooring of the bridge here consists only of about 1 ft. in depth of the stalks, resting on round poles which form the stringers. However, as in the case of the stone bridge, the stringers really constitute the floor, as they almost touch one another and the stalks therefore span only a few inches across the gaps between the poles.

A decided camber is characteristic of all Chinese bridges. It may be seen in the stone-beam bridge as well as in the sorghum-floor bridge, and is found also in the footbridges built at the fords.

War Number of French Bibliography

To fill the war gap in the quarterly bibliography of French scientific and industrial works a special war number of *Les Noveaux Lives Scientifiques et Industrials*, covering the period from June 1, 1914, to Nov. 30, 1918, has been published (Dunod, Editeur, Quais des Gronds—Augustins, 47 et 49, Paris, France; 7½ francs). The bibliography fills 61 large pages, besides subject and author indexes.

Needed: A History of Engineering

By R. Fleming
American Bridge Co., New York City

AN INSISTENT, even if not loud, call has been made during the past few years for a "History of Engineering." Some thoughts of the writer on the subject may not be amiss.

In the first place, he suggests that the proposed history cover the fields represented by the four national societies: The American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. We will therefore have histories of civil, mining, mechanical and electrical engineering.

The term "History of Engineering," used throughout this article, will apply to any or all of these separate histories. The questions at once arise: What shall be the scope of the proposed history? What class of prospective readers shall be held mainly in mind? Under whose auspices shall the history be prepared? By whom shall it be written?

A monumental work in its scope is "A History of the Theory of Elasticity and of the Strength of Materials," by Todhunter and Pearson. The first volume was published in 1886. It was seven years later when the second volume was ready for the press, and even then Professor Pearson said in the preface: "To complete the work as I could have wished it completed would have needed the undivided energies, the fresh and undisturbed intellectual powers of several years' labor. As it is the editor has failed to fulfill the promise made on the title-page and bring the history down to the present time." But the hope of the editor has been realized—the work has taken its place as a standard work of reference, worthy alike of its authors and of the University which publishes it. The books are a series of treatises as well as a history. More than 300 pages are given to St. Venant, nearly 200 to Boussinesq, over 100 to Poisson, 77 each to Clebsch and Kirchoff. A history of engineering written on the same lines would be rather voluminous. However, two features can be especially recommended as a model for future historians: The painstaking care to verify all statements and the use throughout of a uniform terminology and notation.

Engineer Biographies

Books of a different kind are Smiles' "Lives of the Engineers." A great merit of Smiles' books is that they are written in an attractive style and are *readable*. The personalities of the early engineers, Brindley, Smeaton, Rennie, Telford, Watt, the Stephensons, pass vividly in review along with their struggles and accomplishments. Although they are interesting biographies and contain a great amount of historic fact they can hardly take the place of a history. For instance, Rennie's Southwark bridge over the Thames is described as consisting of three spans of cast-iron ribs, the center one "being not less than 240 ft." The weight of cast iron is given as 3,620 tons and of wrought iron 112 tons. The bridge engineer wishes to know more than this. How was a cast-iron arch designed a hundred years ago? What working stresses were used? The mechanical engineer will ask similar questions after reading Smiles' "Industrial Biography."

Another book of unusual merit is Thurston's "His-

tory of the Growth of the Steam Engine." (The third edition of the French translation is dated 1889.) The book is replete with details that we would not wish to see discarded. Opening it almost at random we come across the passage: "William Henry was a prominent citizen of the then little village of Lancaster, Pa., and was noted as an ingenious and successful mechanic. Mr. Henry was the first to make the 'rag' carpet, and was the inventor of the screw-auger. . . . About 1777, when Henry was engaged in making mathematical and philosophical instruments and the screw-auger, which at that time could only be obtained of him, Robert Fulton, then twelve years old, visited him to study the paintings of Benjamin West, who had long been a friend and protegé of Henry." Interesting as such details are, only a limited amount of room can be found for them in a history. If there is not room for both, personal details must give way to professional details, for the history should be an adequate work of reference for students, teachers and professional engineers.

The suggestion is made that a series of biographies be written along with the history. The material for both can be gathered at the same time. A text-book—something like Ball's "History of Mathematics"—could also be prepared from the combined history and biographies. It should always be kept in the forefront that the principal thing sought is the history. Monographs, biographies and textbooks should be by-products of the making of the history. (Sometimes the byproduct has as great a value as the product.)

The Value of Accuracy

An essential of a history is accuracy. This is especially true of an engineering history. To be "reasonably authentic" is not enough. It must be authentic. Dates must be verified, the development of processes traced through their different stages, and conflicting claims passed upon by the collecting of evidence.

It is highly important that data be obtained from original sources of information. Our printed engineering resources are enormous. In the published list of books in the John Crerar Library of Chicago on the History of Industry and Industrial Arts are 58 pages given to books and pamphlets relating to different branches of engineering. The Engineering Societies Library in New York City contains 145,000 books and pamphlets and receives regularly 1,100 publications. The Technology Department of the Public Library of the City of New York numbers over 60,000 volumes. Baltimore, Boston, New Haven, Pittsburgh and other cities have large technical libraries. The Congressional Library at Washington receives issues of all copyrighted books. Many manufacturing concerns possess important specialized collections. The publications of historical societies are sometimes of special interest to engineers; for instance: "A Lost Chapter in the History of the Steamboat," by J. H. R. Latrobe, published by the Maryland Historical Society, 1871. According to a writer in the *Canadian Engineer* the home of civil engineering is the headquarters of the Institution of Civil Engineers, London. In the reading room may be found copies of every engineering and scientific periodical published throughout the world. The library is said to contain copies of every book published on the subject of civil engineering.

The difficulty of selecting material from such an "embarrassment of riches" will be great. Carlyle says in his "Life of Frederick the Great": "Small use in a talent of writing, if there be not first of all the talent of discerning, of loyally recognizing, of discriminating what is to be written." A single case will be cited where discernment is needed:

Telford's Proposed London Bridge

Telford, in 1801, proposed a London bridge of a single cast-iron arch having an opening of 600 ft. with a versed sine of 65 ft. It was to consist of seven ribs and carry a roadway 45 ft. wide. Before any outlay was incurred in the construction, opinions as to its feasibility were obtained from the most eminent mathematicians and engineers of the day. A report embodying their opinions was prepared and submitted to Parliament. (The New York City Public Library has in its possession a copy of this report.) Parliament thought the project far too bold and the bridge was not erected. The report, of 85 pages, is especially interesting as showing the state of science at that time in England. The amount of space that should be given to this and similar reports will often be a problem to the historian. In the "Encyclopaedia of Civil Engineering, Historical, Theoretical and Practical," by Edward Cresy (1847) 18 of the 616 pages given to the "History of Engineering" are taken up with the report on Telford's proposed bridge. Strange to say, the Life of Telford, "written by himself" and published after his death makes no mention of the project.

Great patience will be a requisite in making use of our printed resources. To quote once more from Carlyle's "Frederick the Great": "Truth is, the Prussian Dryasdust, otherwise an honest fellow, and not afraid of labor, excels all other Dryasdusts yet known; I have often sorrowfully felt as if there were not in Nature, for darkness, dreariness, immethodic platitude, anything comparable to him. He writes big Books wanting in almost every quality; and does not even give an *Index* to them." In wading through long lists of patents or through books poorly indexed or not indexed at all, the historian will have a feeling of kinship with Carlyle.

Original Sources of Information

The process of searching for original sources of information is a slow one and not always fruitful. For instance, the idea of the "spread foundation" is attributed to Frederick Baumann, a Chicago architect. He described it in a pamphlet published in or about 1872. A reprint, *revised* by Powell, is printed as an Appendix to Powell's "Foundations," editions of 1879, 1884, 1889. But a reprint of an author's pamphlet revised by another is not the best historical evidence. The original is needed. The writer has failed to find this pamphlet in leading libraries of New York, Chicago and Washington. Another instance: No history of bridge engineering would be complete without a reference to the work of Unwin. In 1868 he delivered a series of lectures in which he recommended that definite working stresses be used instead of a "factor of safety," and higher working stresses be assigned to dead than to live loads. The following year these lectures were published in book form under the title "Wrought Iron Bridges and Roofs." The writer searched for the book in libraries for more than a year before finding two copies in an obscure second-hand book store. Systematized and concerted effort could do much in shortening the time spent in gathering necessary data.

The correct weighing of evidence and apportioning of credit will bring to deserved notice many unfamiliar names. Thurston, in his "History of the Steam Engine," says: " . . . but we shall see, as we examine the records of its history, that although James Watt was an inventor, and probably the greatest of the inventors of the steam-engine, he was still but one of the many men who have aided in perfecting it, and who have now made us so familiar with it, and its tremendous power . . . ." A similar statement may be made concerning other lines of invention as well as of engineering. Many worthy names are often forgotten in the pre-eminence of one. Biographers as a class are given too much to eulogy. In making heroes of their subjects they often fail to weigh evidence impartially and neglect to give credit where it is due.

Work on the proposed history should be begun soon. Smiles spent his spare time for years in gathering material for his biographies. "His works, therefore, have a historical value peculiarly their own. They are a storehouse of facts, gathered not so much from books as from intercourse with the living actors in the events which he chronicles, and from inquiry made on the scene of their labors. He has thus rescued from oblivion many incidents in the lives of the great engineers which would have been irretrievably lost but for his pious and enthusiastic care." When we think of the tremendous strides made in all branches of engineering in the past 50 years and then remember that some of the actors who have taken part are still living, the information which they can give should be obtained and recorded. It was only as far back as 1883 that the first skyscraper was built, a 10-story building in Chicago. The elevator came into existence with the skyscraper. In modern industrial buildings a great factor in the economic handling of material is the traveling crane. The first steam-driven traveling crane was built about 1850, a 20-ton electric traveler was built in France about 1883 and in 1889 the first three-motor crane was built by the Edward P. Allis Co., Milwaukee, Wis. The first high-tension line for the transmission of power in which steel towers were used exclusively was built in Mexico in 1903. These dates are not so far back but that complete and accurate information on high buildings, elevators, traveling cranes, transmission lines—and a score of other subjects as well—can largely be obtained from people now living.

Difficult to Find Publisher

Lack of incentive has probably been the reason why no adequate history of engineering has been written. It is doubtful if an author, after years of labor on such a work, would find a publisher. The purchases by engineers would be few because most engineers want only the latest information on the subjects in which they are interested. This is unfortunate, for no subject is thoroughly understood until its history is known. The sales of the history would therefore be limited almost entirely to libraries. For this reason the expense of bringing out the work would probably be greater than the receipts from sales.

Since it is hardly to be expected that an individual will donate sufficient funds to bring out a history of engineering it is suggested that it be done by the four national societies of engineers. By reason of its being the oldest the initiative belongs to the American Society of Civil Engineers. The field of this society is naturally the largest, covering as it does, bridges, canals, gas works, railroads, steel buildings and many other subjects. It may be seen from the *Proceedings* that the cost of its publications for the years 1913 to 1918 was $215,178.22 or deducting $21,005.81, the amount received from sales, the net expenditures by the society for its publication for five years was $194,172, an average of $38,834.40 per year. So the idea of spending money for publications is not new to this society. If it were to make an initial appropriation of $10,000 toward a history of civil engineering, and further appropriations as needed, and guarantee the publication of the volumes, there could be brought out at the end of five years a work that would be a monument to American scholarship and a standard of reference for years to come.

The same may be said of a history of any other branch of engineering prepared under the auspices of the society covering that particular field. A limit would of necessity be set upon the length of the work. This could best be done after the material was brought together. Perhaps 3 or 4 volumes, of 1,000 pages each, could adequately, but by no means exhaustively, cover the field of civil engineering. Biographies and monographs could be issued, if desired, before the completion of the entire work.

The actual work of writing and compiling would probably be done almost entirely by teachers of engineering. They not only have more time than practising engineers but are able to express themselves more clearly. Let it be remembered that history should be readable. Historians, like poets, are born, not made, and no man should undertake writing history unless he has what may be called the historical sense. He will also need to consult a wider range of books and papers than are found in the library of his own college. While his time would largely be a labor of love, he should be reimbursed for expenses incurred.

The decision as to the scope of the work, the appointment of an editor-in-chief, the assignment of subjects, the co-ordination of diverse opinions, and an endless amount of detail will involve a great deal of effort and labor by the societies taking part. But it is believed that in no other way can we have "A History of Engineering" worthy of the name.

Ohio River Sand Supply

Carl P. Leatherwood, of the Portland Cement Association, Parkersburg, W. Va., is responsible for the assertion that a well-known engineer in that city has compiled figures indicating that the Ohio River from Chester to Kenova, a distance of 273 mi., contains sufficient deposits of sand and gravel to build 45,000 mi. of concrete road, 18 ft. wide, 6 in. thick on the sides and 8 in. in the center. The engineer bases his conclusion on the following data:

Distance of Ohio River from Chester to Kenova, 273 mi.; average width of sand and gravel bars, 300 ft.; average depth of sand and gravel bars, 10 ft.

Assuming that 50 per cent of the length of the river bed is productive, there would be a yield of sand and pebbles of 80,080,000 cu.yd. While there is no way of checking the engineer's estimate, it is generally admitted, says Mr. Leatherwood, that the Ohio River can produce enough sand and gravel so that not a pound of fine or coarse aggregate need be imported to hard-surface every highway in the state.

About $9,000,000 Spent on Lincoln Highway in 1919

ACCORDING to a careful compilation of the expenditures made by the various states and counties through which the Lincoln Highway passes, approximately $9,000,000 has been invested on its improvement in 1919, according to reports from the Lincoln Highway Association headquarters. The Lincoln Highway, which was at first largely a series of connecting county roads, has gradually become an integral portion of the several state-highway systems, through official action of the various states, with the result that the tabulation of expenditures provided direct to the Association by the state-highway departments of the eleven states traversed accurately indicate not only amounts expended but the mileage of improvement accomplished. In the majority of states Federal aid has largely augmented state and county appropriations, the route having been established as a Federal-aid road to be improved directly under the inspection of the Government for more than three-quarters of its total distance between New York and San Francisco.

Following is a statement of expenditures on the Lincoln Highway according to states, made during the season of 1919:

New Jersey	$1,383,572.00
Pennsylvania	1,418,169.28
Ohio	1,902,708.10
Indiana	742,218.30
Illinois	1,430,126.28
Iowa	256,899.29
Nebraska	613,025.00
Wyoming	127,009.94
Utah	225,528.54
Nevada	411,049.58
California	375,500.00
Total	$8,886,800.31

To that figure must be added some county construction and maintenance work and city paving for which it is impossible to get accurate figures. Conservative estimates resulting from actual inspection of such work in progress indicate that these unreported expenditures amount to over $500,000. The total expended during 1919 amounts to over $9,000,000. In addition, more than $2,000,000 has been provided for contracts let, but upon which final expenditures have not been reported.

In addition to maintaining at a considerable cost the Lincoln Highway during the 1919 season, 377.33 mi. of new permanent work have been accomplished, the new mileage being of the following types:

	Miles
Concrete	121.14
Brick	21.28
Bituminous macadam	17.61
Macadam	28.75
Gravel	69.25
Shale	2.00
Permanent earth grade	117.3
Total	377.33

The concrete and brick improvements were largely laid by Eastern States and California.

Owing to the sparsely settled regions west of the Missouri River on the route of the Lincoln Highway the improvement of the thoroughfare beyond the Missouri has been somewhat of a problem, and still is. It is considered that roadbuilding through these sparsely settled states must be considered a national problem and the Lincoln Highway, being a national highway, should therefore be constructed under Federal supervision and with funds partially derived from the United States Treasury. Some assistance has been given far Western States by the Association. Nevada was offered $125,000 should she raise a like amount, and as a result contracts were entered into in 1919 between the State of Nevada and the Lincoln Highway Association calling for the expenditure of over $425,000 of combined state, county and Federal funds in 1920. The Association did considerable work in Utah during 1919, for through the co-operation of the State Highway Department and the contribution of $125,000 by members of the Association, a mountain pass was opened and a cut-off constructed across the great American desert, which opens a route from Salt Lake City to the Pacific Coast.

During the past six years 1,060 mi. have been improved and the mileage has been shortened from 3,389 to 3,223. Something less than 1,000 mi. of highway still remain to be properly improved to an adequate standard, but for long sections the improvement has already been financed or is about to be financed, and the construction is but a question of the time needed to accomplish the work. Classification of the type of roadway along the 3,000-odd mi. is as follows:

	Miles
Concrete	294.84
Brick	212.58
Bituminous macadam	425.60
Macadam	286.65
Asphalt	78.00
Creosote block	5.90
Granite block	7.10
Graded gravel	770.75
Natural gravel	200.00
Shale	17.00
Graded dirt	817.57
Natural dirt	93.70
Sand	13.30
Total	3,223.00

Gas Holders Lawful Structures

Gas holders within city limits are lawful structures, according to the findings of the Massachusetts Board of Gas and Electric Light Commissioners, presented recently in a special report to the General Court at Boston. The investigation by the board was occasioned by the introduction last year of a House bill declaring unlawful the maintenance or operation of a gasometer "within 100 rods of a dwelling house in the City of Boston." The board, after discussing the general features of gas holders and the details of the North End holder of the Boston Consolidated Gas Co., which has a capacity of 2,500,000 cu.ft., a diameter of 160 ft. and rises to a height of 140 ft. above the foundation, submits the following conclusions:

"The gas holders now standing within the limits of the City of Boston, and particularly the North End holder, are lawful structures. A gas holder properly designed, constructed and operated is not *per se* a menace to the public safety and health, even though located in a thickly settled community such as the North End. The laws now in force requiring permits and prescribing safeguards for the structural safety of gas holders hereafter erected are ample. The use to which a holder is put is such as to involve little likelihood of developing structural weaknesses and possible danger to the public safety or health.

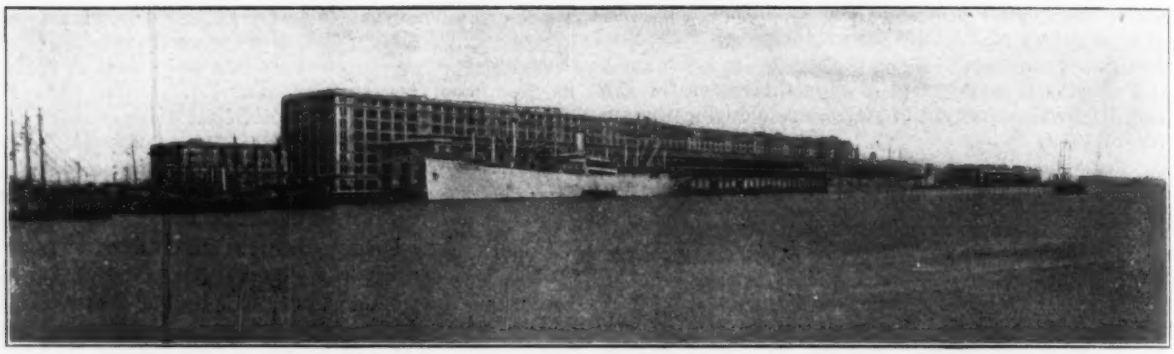
"So far as gas holders in use may become a nuisance or a menace to the public health, the board of health, as already indicated, has full power to deal with the situation, and in addition any party injured has his remedy at law for damages or in equity to enjoin the nuisance. A gas company cannot be deprived without compensation of the beneficial use of a gas holder merely on æsthetic grounds or for the improvement of the neighborhood in which it stands.

"In view of all the facts the Board deems that the proposed legislation is inexpedient."

Cost-Plus Contract Satisfactory on Boston Army Base

$25,000,000 Job Built Below Estimate at Unit Costs Slightly Above Similar Work Put Up Under Pre-War Conditions

BUILDING contracts during the war did not fairly represent normal conditions. It is doubtful if any but a cost-plus system could have been used in the rush of 1917 and 1918, certainly not on those jobs where construction progressed along with design. However, there has been much criticism of the cost-plus-fee contract, and allegations have been freely made that under it money was wasted shamefully on most of the war construction built under this form of contract. Regardless of the merits of such criticism in general, the operation of this form of contract on the Boston Army Supply Base is commended by the Constructing Quartermaster there, Lt. Col. Charles R. Gow, who before the war was a well-known engineer and contractor in Boston and who has now returned to private practice. It is Col. Gow's judgment that in spite of the unfavorable conditions as to labor and material under which the Base was built, the work was carried out as rapidly, as economically, and as well as any similar work under the lump-sum form of contract in pre-war times.



VIEW OF BUILDINGS OF THE BOSTON ARMY SUPPLY BASE

The Boston Army Supply Base, which was described in *Engineering News-Record*, Sept. 19, 1918, p. 522, consists of an enormous storehouse containing 1,600,000 sq.ft. of floor area, a three-story pier shed containing 500,000 sq.ft. of floor area, and a two-story wharf or cargo shed of approximately 325,000 sq.ft., in addition to minor buildings, such as power stations, electric supply stations, administration building, and the like. There were also involved the dredging of over 3,000,000 cu.yd. of material and the construction of 5,400 lin.ft. of concrete wharf, 18 miles of railroad track, water, sewerage, and drainage systems, and the many other factors which enter into the construction of a modern port terminal. Buildings were of the most modern up-to-date type of reinforced concrete, with every appointment and facility needed to produce an efficient shipping terminal for receiving, storing, and handling at the rate of 15,000 tons of supplies per day.

The estimated cost of this project was $28,043,000. The actual completed cost for the project—of practically the same scope as the one for which the estimate was made—was $23,250,000. The summary of costs is given in Table I. It will be noted that there the summation gives a total of $23,800,829, or about $550,000 in excess of the final actual figures as noted above. The discrepancy is due to the fact that the cost figures in the table were made up last spring, whereas the final accounting was not completed until August, 1919. The difference is fairly well distributed among the various items, and is of no percentage importance in the summary.

The contract was let on the well-known Construction Division form, that is, cost plus a maximum fee. Work was begun on April 22, 1918. It was entirely completed in 13 months, but six months after it was started, the project was in partial use by the Government and it was used in its entirety within nine months, although minor features of construction work were made and completed until the ensuing four months had passed. This speed of construction is remarkable, regardless of cost, but it is a fact that the unit costs were not very much greater than for similar work during a normal period.

The work was undertaken during a time when war work was at its maximum. There was a great shortage in labor of all classes, and those obtainable were not on the average particularly efficient. Necessities of the case required continuous operation day and night, involving an enormous amount of overtime work for which bonus rates were paid in accordance with established union conditions in Boston, one of the strongest union cities in the United States. As a result, the average wage paid to the 7,000 men employed in the construction of this work was $7.59 per day. The forced conditions of progress made it necessary to maintain a maximum crew of men at all times in the several departments of the work, and prevented the application of the usual economic principle of transferring men from one employment to another, as the demand required.

Furthermore, the tremendous rise in values of materials and the difficulty of obtaining any sufficient quantities, and the necessity of purchasing large amounts of supplies from local retail stocks in order to maintain the continuity of output, would account for a very considerable increase in unit costs over normal times. On account of these conditions the Government anticipated costs approximately 50% in excess of pre-war times. The original estimates were based upon some such consideration.

It is, of course, difficult to make a direct comparison of the unit costs with any other work. The Boston Army Base buildings were of reinforced-concrete construction of a design much heavier than was ever used in the Boston district. The minimum floor design was for 300 lb. per sq.ft., and the maximum 600 lb. On account of the heavy type of construction and the completeness of equipment with which these buildings are provided, it is not possible to obtain exact comparisons between the unit costs and those of similar buildings in the same locality built before the war.

The cost of the main storehouse is shown in Table II, exclusive of so-called indirect and overhead charges. Table III shows the so-called indirect and overhead charges for the whole work. Some explanation should be made of the accounting. It will be noticed that the indirect and overhead charges amount to some 32.1% of the total cost of the work. They involve the general construction plant features applicable to the whole job, the contractors' and subcontractors' fees, the cost of the field office organization of the constructing quartermaster, not including the salaries of the army officers, which are in the aggregate so small as not to affect the total, the cost of the engineering, the field and office organization of the contractor, and the premiums on bonds and liability and workmen's compensation insurance.

A number of these features are very much larger than they would have been on normal work. The field and office organization of the contractor, for instance, was unusually large, because of the necessity for complying with Government requirements as to accounting procedure. The premiums on liability and compensation insurance, being based upon the payroll, are almost double for this work the amount which would have been paid under normal conditions and prices. There is likewise a considerable excess of cost in the miscellaneous indirect charges for temporary facilities due to the rush nature of the work, which made necessary the erection of extremely large storage buildings, an elaborate lighting plant for night work, and much duplication of equipment which could have been avoided under conditions of normal progress.

It will be noted that the contractor's and subcontractor's fees, as given in Table III under the head "Indirect Charges," amount to $625,000. Final accounting increased this amount to $638,486.46, distributed as follows:

General contractor	$250,000.00
Plumbing contractor	11,861.52
Heating contractor	35,000.00
Electrical contractor	25,526.42
Railroad, paving and underground contractor	87,500.00
Foundation contractor for storehouse	60,000.00
Foundation contractor for pier shed	68,598.52
Wharf work contractor	100,000.00
Total	$638,486.46

The combined fees paid and profits of the general contractor and all of the subcontractors amounted to 2⅜% of the cost of the project. The cost of engineering was about 2½%, including all salaries, supplies,

TABLE I. SUMMARY OF ALL COSTS ON BOSTON ARMY SUPPLY BASE

Structure	Total Cost			Size of Structures		Construction—Unit Costs			
						Square Foot Costs		Cubic Foot Costs	
Item	Construction Costs (Not Including Indirect and Overhead Charges)	Indirect and Overhead Charges (Prorated)	Construction Costs (Including Indirect and Overhead Charges)	Gross Floor Area, Sq.Ft.	Gross Volume, Cu.Ft.	Not Including Indirect and Overhead Charges	Including Indirect and Overhead Charges	Not Including Indirect and Overhead Charges	Including Indirect and Overhead Charges
Clearing site	$29,704	$9,534	$39,238	.....	.....	.....	.....	.....	.....
Dredging	1,444,000	463,453	1,907,453	.....	.....	.....	.....	.....	.....
Railroads	612,230	196,496	808,726	.....	.....	.....	.....	.....	.....
Streets	192,782	61,874	254,656	.....	.....	.....	.....	.....	.....
Water supply	223,968	71,883	295,851	.....	.....	.....	.....	.....	.....
Sanitary sewers	56,519	18,140	74,659	.....	.....	.....	.....	.....	.....
Storm sewers	58,675	18,832	77,507	.....	.....	.....	.....	.....	.....
Electrical distribution system	128,941	41,384	170,325	.....	.....	.....	.....	.....	.....
Miscellaneous buildings	16,000	5,135	21,135	.....	.....	.....	.....	.....	.....
Fence	10,100	3,242	13,342	.....	.....	.....	.....	.....	.....
Granolithic sidewalks	3,304	1,060	4,364	.....	.....	.....	.....	.....	.....
Cargo stages and gangways	8,200	2,632	10,832	.....	.....	.....	.....	.....	.....
Administration building	237,759	76,309	314,068	33,350	417,000	$7.13	$9.42	$0.57	$0.75
Storehouse	.....	.....	.....	1,689,000	24,000,000	.....	.....	.....	.....
Foundations	1,266,588	406,512	1,673,100	.....	.....	.75	.99	.05	.07
Superstructure	5,232,252	1,679,296	6,911,548	.....	.....	3.10	4.09	.22	.29
Unloading platform and canopy	110,065	35,325	145,390	38,000	.....	2.90	3.83	.....	.....
Heating tunnel (under storehouse and to boiler house)	110,372	35,424	145,796	.....	.....	.....	.....	.....	.....
Bridges from storehouse to wharf shed	55,184	17,711	72,895	.....	.....	.....	.....	.....	.....
Wharves (including foundations for wharf shed)	1,522,218	488,557	2,010,775	389,100	.....	3.91	5.17	.....	.....
Wharf shed (above wharf deck)	1,485,276	476,700	1,961,971	327,600	9,100,000	4.53	5.99	.16	.22
Boiler house									
Building	182,279	58,503	240,782	.....	.....	.....	.....	.....	.....
Equipment	263,979	84,724	348,703	.....	.....	.....	.....	.....	.....
Electric sub-station									
Building	76,018	24,398	100,416	.....	190,000	.....	.....	.40	.53
Equipment	116,000	37,230	153,230	.....	.....	.....	.....	.....	.....
Fire station	11,364	3,647	15,011	2,675	34,400	4.25	5.61	.33	.44
Pier shed	.....	.....	.....	562,200	10,400,000	.....	.....	.....	.....
Bulkhead	321,895	103,312	425,207	.....	.....	.....	.....	.....	.....
Sub-structure (including 1st floor)	939,384	301,496	1,240,880	.....	.....	1.67	2.21	.09	.12
Superstructure	2,049,748	657,868	2,707,616	.....	.....	3.66	4.83	.20	.26
Wharves at pier shed	255,750	82,083	337,833	63,000	.....	4.06	5.36	.....	.....
Total	$17,020,554	$5,462,760	$22,483,314						
Total indirect and overhead charges	5,462,760								
Total construction costs including above charges	$22,483,314	.....	.....	.....	.....	.....	.....	.....	.....
Cost of land	1,317,515	.....	.....	.....	.....	.....	.....	.....	.....
Total cost of project	$23,800,829	.....	.....	.....	.....	.....	.....	.....	.....

Indirect and overhead charges equal 32.10% of the construction cost.

TABLE II COST OF STOREHOUSE, INCLUSIVE OF FOUNDATIONS, AND EXCLUSIVE OF INDIRECT AND OVERHEAD CHARGES, BOSTON ARMY BASE, JUNE, 1919

Description	Unit	Quantity	Material	Material Unit Cost	Labor	Labor Unit Cost	Total Cost	Total Unit Cost	Notes
Excavation and backfill	.....	.....	.....	.....	$408	.....	$408	.....	Partial cost of excavation of elevator pits.
Concrete cylinder piers	Number	577	$412,641	$715.10	853,947	$1,480.00	1,266,588	$2,195.10	(See detailed estimate sheet.)
Forms—metal	Sq.ft.	329,000	23,640	.07					Metal forms used on round columns only.
Forms—wood	Sq.ft. Contact Surface	2,594,000	256,979	.10	947,780	.32	1,228,399	.42	
Reinforcing	Tons	7,000	674,433	96.35	180,950	25.84	855,383	122.19	Average cost of reinforcing was $82.40 per ton, excl. of handling.
Concrete mixing and placing	Cu.yd.	84,412	673,000	7.96	184,802	2.19	857,802	10.15	Cement $2.17 per bbl.; sand $2.28 per cu.yd.; gravel $3.49 per cu.yd.
Miscellaneous iron	Tons	366	66,429	181.00	38,833	105.00	105,262	286.00	Includes col. guards, door sills, stair-treads, railings, inserts, building hardware, etc.
Brick work (sand lime)	Number M	2,902	56,367	19.42	56,871	19.53	113,238	38.95	Cost of bricks $10.50 per M; lime $16 per ton.
Terra cotta partitions	Sq.ft.	33,542	4,757	.14	3,354	.10	8,111	.24	Cost of 6-in. terra cotta blocks 10½c. per sq.ft.
Rubbing and patching	Sq.ft.	340,000	1,473	.004	67,000	.20	68,473	.20	
Plastering	Sq.ft.	65,725	1,737	.03	9,202	.14	10,939	.17	
Cinder crickets	Sq.ft.	192,300	2,173	.01	8,116	.04	10,289	.05	Material item includes cost of cement only. Cinders supplied from job.
Cement finish on roof	Sq.ft.	192,300	3,214	.02	6,298	.03	9,512	.05	
Roofing	Squares	2,158	22,120	10.25	.....	.....	22,120	10.25	Sub-contract.
Flashing, etc	.....	.....	4,365	.....	481	.....	4,846	.....	Plastic slate flashing 13c. Metal flashing 30c. per sq.ft.
Steel sash, glazing and painting sash	Sq.ft.	172,000	95,100	.55	17,200	.10	112,300	.65	Labor item includes glazing and painting only. Sash furnished and erected at 22c. per sq.ft.
Picking concrete	Sq.ft.	1,332,000	.....	.....	44,517	.03	44,517	.03	
Granolithic	Sq.ft.	1,332,000	48,000	.04	42,617	.03	90,617	.07	
Wood block paving	Sq.yd.	20,412	43,336	2.12	11,343	.55	54,679	2.67	Cost of wood blocks $1.86 per sq.yd.
Painting (oil)	.....	.....	1,815	.....	28,500	.....	30,315	.....	Used on iron, steel, piping, doors, trim, etc.
Painting (cold water)	Squares	18,943	3,839	.20	19,537	1.03	23,376	1.23	Used on walls, ceilings, columns, etc. Brush work.
Steel doors	Number	130	74,090	570.00	499	3.84	74,589	573.84	Kinnear vertical lift doors.
Wood doors	Number	78	821	10.52	16	.....	837	10.75	Erection cost not included. Cost includes door frames.
Fire doors (tin clad)	Sq.ft.	19,314	17,350	.88	15,780	.81	33,130	1.69	This cost includes hardware.
Heating	Sq.ft. Radiation	76,839	130,869	1.70	47,815	.62	178,684	2.32	This cost does not include any proportion of the general heating plant, nor of hot water sprinkler system.
Plumbing	Number of fixtures	270	84,694	.....	42,288	.....	126,982	.....	Includes rain water leaders.
Lighting	Number outlets	5,248	164,400	.....	129,000	.....	293,400	.....	This cost does not include any proportion of the general electrical distribution plant.
Elevators	Number	30	565,600	.....	881	.....	566,481	.....	24 freight elevators at $21,110 each; 6 passenger elevators at $11,460 each. This price includes automatic hatchway doors, etc.
Sprinkler system and fire protection	Heads	16,680	298,000	.....	.....	.....	298,000	.....	Combination hot water sprinkler system and fire protection apparatus.
Miscellaneous equipment	.....	.....	6,364	.....	3,299	.....	9,563	.....	Scales, trucks, etc.
			$3,737,606		$2,761,234		$6,498,840		
Loading platform and canopy	Sq.ft. each	38,000	60,092	.....	49,973	.....	110,065	.....	Exclusive of indirect and overhead charges.
Total storehouse (inclusive of foundations)			$3,797,698		$2,811,207		$6,608,905		

The storehouse is 1,638 ft. long by 126 ft. wide by 8 stories high. Gross square feet floor area 1,689,000. Gross cubic contents 24,000,000 cubic feet.

and expenses, except the salaries of the army officers. Reverting back to Table I, it will be seen that the direct cost above foundation of the main storehouse, a building with cubic contents of 24,000,000 cu.ft. and a floor area of 1,689,000 sq.ft., is 22c. per cu.ft., not including indirect and overhead charges. The indirect and overhead charges pro rated from Table III amount to 7c., so that the cost per cubic foot, including all indirect charges and excluding the foundation, which was extremely heavy, amounts to 29c.

An attempt was made by Col. Gow to compare the costs with previous work, on a fair basis. It is his conclusion that of the 7c. per cu.ft. included in the tabulation of indirect charges a certain percentage is necessarily large in comparison with more normal work, for the reasons set forth in the preceding paragraphs. He therefore assumed that 4c. would be a fair amount to charge for the indirect expenses in any comparison with pre-war construction. As nearly as he could ascertain from such inquiries as he made, buildings of a similar general type, but not nearly as substantial in character or equipment, were costing under competitive conditions in 1916-17 from 22 to 24c. per cu.ft. above the foundation. Deducting the 4c. for indirect charges would reduce this price to 18 or 20c. per cu.ft., which is to be compared with the 22c. of the Army Base storehouse figures. Under the same method of figuring, the pier shed cost 20c. per cu.ft. above the foundation and the wharf shed 16c. per cu.ft.

As a further comparison it may be stated that if the entire cost of the Army Base project, including the open wharves, open storage space, railroad yards and similar items, were put upon the cost of the buildings and the buildings were then rented on a basis which would yield to the Government 4½% income, the Government would be able to lease the three main buildings at an average rental of 43c. per sq.ft. per year.

This compares with 50 to 55c. now being charged in this locality for buildings of an inferior type having no water and scant railroad facilities. Buildings similar to the storehouse are now costing from 30 to 35c. per cu.ft. around Boston.

TABLE III. INDIRECT AND OVERHEAD CHARGES ON BOSTON ARMY SUPPLY BASE
(As of June, 1919)

Description			
Indirect Charges			
Unloading and loading plant	$290,000		
Towers and storage bins	156,500		
Operation of construction equipment not directly chargeable	400,000		
Repairs to construction equipment	237,000		
Cost of construction equipment worn out on the work	115,000		
Rental of construction equipment not directly chargeable	89,000		
Tools and reapirs to tools (including operation of blacksmith shop)	245,000		
Temporary lighting and power	213,000		
Temporary water supply	47,000		
Temporary buildings	360,000		
Temporary roads	160,000		
Temporary heat	23,000		
Maintenance of existing roads, off of site	600		
Temporary tracks	61,000		
Guards, watchmen and firemen	110,000		
Sanitation	26,000		
General cleaning up	84,000		
Contractor's and sub-contractor's fees	625,000		
Other indirect expenses (too small for separate account)	63,000		
Freight and express charges paid on materials not charged directly	23,000		
Purchase, operation, maintenance and rental of trucks, ambulance, fire apparatus, etc	33,000		
Team service	3,400		
			$3,364,500
Overhead Charges			
Field Office Organization of Constructing Quartermaster			
Salaries	$410,000		
Transportation and expenses	1,000		
Office furniture and fixtures	14,900		
Office supplies and expenses	33,000		
Purchase, operation, maintenance and rental of automobiles	6,200		
		$465,100	
Engineering			
Consulting engineers, fees and expenses $65,000			
Salaries, assistants and inspectors.. 410,000	475,000		
Associate engineers on heating—fees, salaries and expenses	26,500		
Engineering supplies and miscellaneous expenses	90,500	592,000	
Field and Office Organization of Contractor			
Salaries	$501,150		
Transportation and expenses	11,000		
Office furniture and fixtures	21,500		
Office supplies and expenses	50,000		
Purchase, operation, maintenance and rental of automobiles	35,000		
		618,650	
Miscellaneous			
Premium on bonds	$2,510		
Premiums on liability and workmen's compensation insurance	420,000		
		422,510	2,098,260
Total			$5,462,760

The form of contract and its adaptation to Government work were the result of studies and examinations made by Brig. Gen. R. C. Marshall, Jr., Chief of the Construction Division. The work was let to W. F. Kearns Co., Boston, general contractor, and the engineers were Fay, Spofford & Thorndike, of Boston.

Accidents to Railroad Employees Decrease

Records compiled by the Safety Section of the Division of Operation, United States Railroad Administration, recently made public by the Director General, show that during the first ten months of 1919, 1,107 fewer employees were killed in accidents and 25,930 fewer employees were injured during the corresponding period of 1918. Since the Safety Section had only begun to function in January, 1919, these figures are considered evidence of the application of safety practices.

Tunneling Machines Successful on Detroit Sewers

Machines Drive 10 to 12 Ft. Bore 12 to 15 Ft Per Day—Either Concrete or Brick Lining Practicable

MACHINES which bore a tunnel to full size in a single auger-like operation are demonstrating their economic success in the construction of the new outer-ring sewer system for the City of Detroit, Mich. Tunnels for sewers from 7 to 9½ ft., interior diameter, are being bored with equal success, and both concrete and brick sewer rings are being constructed behind the machines. An advance of 20 ft. a day is not uncommon, and an average progress of 12 to 15 ft. a day has been recorded over long periods. A homogeneous material which cuts smoothly and will stand unsupported for distances up to a day's advance is necessary for the best success of the machines. A material which contains boulders or unstable spots and in which roof support is necessary, complicates the problem of using the machines successfully.

Tunneling for circular sewers of the larger sizes has become virtually standard practice in Detroit. On the new outer-ring sewer system tunneling operations by hand, with shields and with tunnel boring machines are in progress. The city's remarkable subsoil conditions are the reasons for this general practice of tunneling. Under a 10 to 12-ft. crust of stiff, yellow clay there is a great depth of material which physically resembles a very smooth blue clay. Ordinarily, boulders or stones of any size are remarkably scarce. At points of the city area, sand in the form of pockets or strata is interspersed with the clay or is mingled with the clay and produces areas less stable than the clay. The clay contains some water but is quite impenetrable by water. In its best character it will stand unsupported in tunnel for considerable distances and periods of time. From this perfection of stability it varies in all degrees to material which must be closely braced. In a broad sense, Detroit clay may be classified as a stable material for tunnel construction.

Tunnel boring machines are not a device which is new with the construction of the new outer-ring sewer system. A machine of one of the two forms now being used was successfully employed as long ago as 1914. The other form of machine was first used in 1916. Since then both forms have been repeatedly employed and brought to greater perfection. Both machines are alike in the respect that each consists of a cutter head on a horizontal axial shaft operated by an electric motor and all mounted on a carriage.

Boring Process

With the older machine, known locally as the Carpenter machine, the face is excavated, working outward from the center, in concentric ribbons. The earlier form of this machine and its operation were described in *Engineering News*, Oct. 29, 1914, p. 874. The strips cut from the face drop to the tunnel floor and are loaded by hand into buckets directly, in tunnels of small section, and, in tunnels of large section, onto a belt conveyor which extends back from the machine to cars on the tunnel service track. With the more recent machine, known as the Anderson machine, a thin sheet the full diameter of the face is removed at each revolu-

tion of the cutter head. Radial buckets catch the material and guide it to an axial screw which feeds onto a belt conveyor leading back to spoil cars.

In the Carpenter machine, there is provision for feeding forward the cutter head for 2 to 3 ft., independently of the carriage. When this advance has been completed the cutter head is drawn back and the carriage is run ahead for a new drive. The advance of the Anderson machine is continuous, it being mounted on multi-ped drivers. Both machines cut a true cylinder, quite smooth inside, ordinarily 3 in. larger in diameter than the outside diameter of the planned sewer section. Change of diameter is accomplished by contracting and expanding the cutter heads.

Linwood Ave. Operations Typical

Typical operation is represented by the work of contractors Jaynes & Affeld on Linwood Ave. Machine tunneling is here employed for three-ring brick sewers from 8 ft. 9 in. to 9 ft., to 9 ft. 3 in., to 9 ft. 6 in. in diameter. Shafts are sunk at 1,000-ft. intervals and machines are worked both ways from each shaft, giving continuous drives of 500 ft. for each machine. A 9-hr. day shift is operated—8 hr. boring and 1 hr. cleaning the machine for the next day's work. Average and maximum daily advances for a typical month are

TABLE I. TUNNELING MACHINE OUTPUT ON LINWOOD AVENUE SEWER FOR TYPICAL MONTH

Sec. I—Anderson Machine					Sec. II. Carpenter Machine				
Shaft No.	Size Ft.	In.	Aver. Ft.	Max. Ft.	Shaft No.	Size, Ft.	In.	Aver. Ft.	Max. Ft.
1	9	6	12	16	1	9	0	11½	13
2	9	6	14½	19	2	9	0	11	14
3	9	3	15½	20	3	8	9	12	15
4	9	3	14	18½	...	...	...	...	..

given in Table I. Spoil is handled from heading to shaft in boxes on cars and at the shafts is hoisted and dumped into wagons. Where timbering is required, it consists usually of roof cants to the quarter points, with their feet set into notches cut into the clay walls. These cants support blocking, which carries lagging plank.

During the night shift, the day shift drive is bricked up. Usually the procedure is about as follows: All the bricklayers, five or six, start behind one machine and complete the invert and erect the ribs for the arch centers. These ribs are steel channels. Then about half of the gang is shifted to the opposite heading to build invert while the other half remains in the first heading to construct the arch. Brick and mortar are brought from the shaft top in cars on the tunnel track.

As examples of typical gangs, one gang on 9 ft. 6 in. sewer and another on 8 ft. 9 in. sewer, are selected. These gangs are averaged for a month.

ANDERSON MACHINE

Day	Night
1 foreman	1 foreman
4 muckers	6 bricklayers
8 wheelers	10 helpers
4 machine operators	5 topmen
6 teams on top	1 engineman
5 laborers on top	1 night foreman
1 engineman	
1 handy man	
30—Total	24—Total

On the 9 ft. 6 in. sewer, the average time worked was 8 hr. excavating and 10 hr. bricklaying per day. The sewer required about 550 brick per lineal foot. The force listed was divided between two headings or two tunneling machines.

On the 8 ft. 9 in. sewer the average time worked was 8 hr. excavating and 8 hr. bricklaying. The sewer required about 515 brick per lineal foot. As in the larger tunnel the men listed were divided between two headings.

CARPENTER MACHINE

Day	Night
1 foreman	1 foreman in tunnel
8 muckers	4 bricklayers
8 wheelers	6 helpers
4 machine operators	2 mortar men
1 engineman	3 piling brick
5 teams	1 engineman
1 handy man	1 night foreman
2 dumpers	
5 laborers on top	
35—Total	18—Total

To allow a more general average and to eliminate the personal equation in gang handling which may characterize records from the operations of one contractor the gang employed on a 9-ft. sewer by the J. Connelly Contracting Co. is given. On this contract the average daily advance per heading is 12 ft., the drives being short due to poor roof. The gang is divided between two headings, as in other examples given, and is as follows:

ANDERSON MACHINE

Day	Night
1 foreman	1 foreman
2 machine operators	4 bricklayers
4 machine helpers	4 helpers
2 top men	2 mules and drivers
2 dump men	1 elevator man
4 teams	3 laborers below
3 motor trucks	2 mortar men
4 muckers	3 piling brick
2 mules and drivers	1 engineman
2 elevator men	
26—Total	21—Total

Based on the data given and on other data collected but not given the following general statements of experience with tunnel-boring machines in Detroit are possible.

For sewers of sizes in which competition between machine driving and hand driving is possible, the comparative daily progress per heading is 8 to 10 ft. for hand work and 12 to 15 ft. for machine work.

The bore made by machine is more smooth and more true to size than the bore made by hand. This is found to be an advantage in two particulars: (1) Less packing is required to fill voids outside the planned section; it is estimated that the reduction due to this cause is 3 to 4 per cent in the volume of brick used. (2) Compared with the gouged surface left by hand excavation the smooth cut of the machine forms an earth arch which has less tendency to scale and cave.

True alignment of the boring machine is necessary to develop these advantages, and reasonably careful checking is required to hold the bore true. Ordinarily, true center is given to the machine operators every two hours. The tendency of the machine is normally to "nose-up." This tendency is not counteracted too strongly, since if a rise or a dip is to occur it is better that it should be a rise; the extra excavation required to correct the bore is more easily accomplished in the invert than in the roof.

Horizontal curves are successfully turned. On 8½-ft. sewer two 50-ft. radius curves were turned and the average drive per day was 13 ft.

The space occupied in the heading is 12 ft. by the Anderson machine and 9 ft. by the Carpenter machine. These lengths of bore cannot be bricked up and this introduces in machine tunneling a constant length of roof which must stand unsupported by masonry for a

considerable period. In uncertain ground this is a difficulty which complicates machine tunneling. If boulders or large stones are encountered the machines must be stopped and the obstruction be removed by hand.

Machine failures are rare with the latest improved designs. Most trouble is experienced with conveyor breakdowns. Machine improvements which have suggested themselves are provision for withdrawing the machine from the face back into the completed lining to permit lining to be carried close to the face or the face to be quickly got at for emergency bracing, and provision for boring and lining simultaneously, making the tunneling operation continuous.

The outer-ring sewer system on which the operations described are in progress is being constructed under the direction of City Engineer C. W. Hubbell, with J. R. Hendry as designing engineer and A. L. Sears as construction engineer.

Eccentric Loading in Rigid Frames

How the Fundamental Frame Formulas May Be Applied When Columns of Frame Have Loads Applied Eccentrically

By F. E. Richart
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In THE design of rigid frames, particularly those of reinforced concrete, it is frequently desirable and sometimes necessary to introduce eccentric loads on the columns of the structure. Examples are to be found in crane brackets on the columns of factory buildings and in balcony or gallery cantilevers attached to the columns in theaters, gymnasiums, and similar buildings.

The stresses in eccentrically loaded columns have been analyzed by many writers, particularly for the special cases of hinged and fixed ends, and with the load applied at any point along the height of the column. It is the purpose of this article to discuss a general method of investigating the moment distribution in a rigid frame having eccentrically loaded columns, in which case the column ends are usually only partly restrained.

The frame shown in Fig. 1 may be studied by making use of the analysis of a frame similar to this one but having a horizontal load applied at the point E instead of the eccentric vertical load. Such an analysis is given in Bulletin 108, Engineering Experiment Station, University of Illinois, as an example of the use of the "slope-deflection" method. The expressions which are given for the moments at the corners of the frame are

$$M_{AB} = -\tfrac{1}{2}\left[C_{AD}\, n\left(\frac{n+2p}{\alpha}+\frac{3}{\beta}\right) + C_{DA}\, n\left(\frac{p}{\alpha}+\frac{3}{\beta}\right) - M_O\left(\frac{3n+p}{\beta}\right)\right] \quad (1)$$

$$M_{BC} = -\tfrac{1}{2}\left[C_{AD}\, n\left(\frac{n+2p}{\alpha}-\frac{3}{\beta}\right) + C_{DA}\, n\left(\frac{p}{\alpha}-\frac{3}{\beta}\right) + M_O\left(\frac{3n+p}{\beta}\right)\right] \quad (2)$$

$$M_{CD} = -\tfrac{1}{2}\left[C_{AD}\, n\left(\frac{1}{\alpha}-\frac{3}{\beta}\right) + C_{DA}\, n\left(\frac{n+2}{\alpha}-\frac{3}{\beta}\right) - M_O\left(\frac{3n+1}{\beta}\right)\right] \quad (3)$$

$$M_{DA} = -\tfrac{1}{2}\left[C_{AD}\, n\left(\frac{1}{\alpha}+\frac{3}{\beta}\right) + C_{DA}\, n\left(\frac{n+2}{\alpha}+\frac{3}{\beta}\right) + M_O\left(\frac{3n+1}{\beta}\right)\right] \quad (4)$$

in which $n = I_1 h / I_2 l$, $p = \dfrac{I_1}{I_2}$, $\alpha = n^2 + 2n + 2np + 3p$, and $\beta = 6n + p + 1$. The moments are considered positive when they tend to rotate the member in a clockwise direction.

The four terms, n, p, α and β are seen to be constant

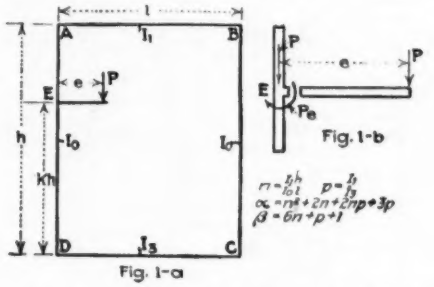


FIG. 1. DIMENSION AND MOMENT RELATIONS IN ECCENTRICALLY LOADED FRAME

for any given dimensions of the members of the frame, while the terms C_{AD}, C_{DA} and M_O depend upon the loading. C_{AD} and C_{DA} are the moments which would occur at A and D respectively, due to the given loading, if the ends at A and D were fixed. M_O is the moment of the external loads about the point D.

It has been noted that equations (1) to (4) have been derived by the use of the slope-deflection method, which consisted in writing an equation between moments, slopes and deflections for each of the component members of the frame, and solving for the unknown moments. The general form of the slope deflection equation, expressing the value of the moment at the end A of a member AB carrying transverse loads P_1, P_2, etc., is

$$M_{AB} = \frac{2EI}{l}\left(2\theta_A + \theta_B - 3\frac{d}{l}\right) \pm C_{AB}$$

where E is the modulus of elasticity of the material, I is the moment of inertia of the cross section (considered

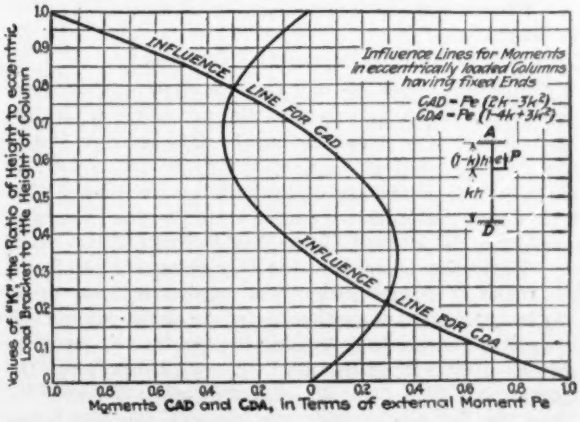


FIG. 2. END MOMENTS OF COLUMN AS AFFECTED BY POSITION OF BRACKET

constant throughout the length of a member), l is the length of the member AB, θ_A and θ_B are changes in slope from the initial position at A and B respectively, d is the deflection of one end with respect to the other, and C_{AB} is the moment which would occur at A if AB were a fixed beam and subjected to the same transverse

loads P_1, P_2, etc. It is clear that if the loads P_1, P_2, etc., are replaced by a couple; the only result on the calculations will be to change the value of the quantity C_{AB} in the slope-deflection equation, and hence in the derived equations (1) to (4).

From Fig. 1b it may be seen that the eccentric vertical load produces at E a couple Pe and a direct compressive force P in the column. The values of the three load terms due to this couple Pe now become

$C_{AD} = Pe\ (2k - 3k^2)$

$C_{DA} = Pe\ (1 - 4k + 3k^2)$

$M_O = Pe$

where k indicates the proportional height of the column at which the eccentric load acts. These values of C are given in various text-books; see, for example, Hool & Johnson's "Reinforced Concrete Handbook," p. 383. Fig. 2 shows influence lines for C_{AD} and C_{DA}, as the couple Pe is considered to act at successive points on the column.

It is to be noted that equations (1) to (4) will apply to a frame having the columns fixed at the bases if the term p is set equal to zero; that is, the member CD is made infinitely stiff and unyielding. On the other hand, the equations may be simplified so that they will apply to a frame having the columns hinged at the bases by making the member CD become infinitely flexible, so that the ratio I_1/I_2 approaches infinity; then all terms in the equations which do not contain the quantity p may be neglected.

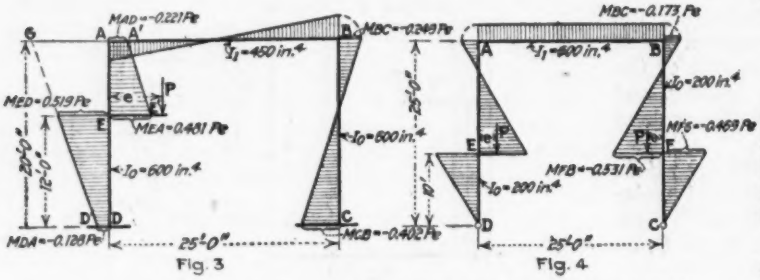


Fig. 3 Fig. 4

FIGS. 3 AND 4. TWO EXAMPLES FOR FRAME CALCULATION

Two Illustrative Examples

A numerical example will serve to illustrate the foregoing statements, and to show the procedure in attacking this sort of problem. From the data given in Fig. 3, for a frame *fixed at base*, $n = 0.6$, $p = 0$, $\alpha = 1.56$ and $\beta = 4.6$. By reference to the influence lines of Fig. 2 it is seen that with the couple acting on the column at height 0.6, the moment $C_{AD} = 0.12\ Pe$ and $C_{DA} = -0.32\ Pe$. Hence the moments at the four corners of the frame are found by substituting these numerical terms in eq. (1) to (4). It is known that the shear in the column AD is constant; hence to determine the moment variation in this member, extend the line $A'A$ which represents the moment at A, to G, making $A'G$ equal to moment Pe. Then the line GD' bounds the moment diagram below the point E, and the parallel line $A'E'$ bounds the moment diagram above the point E. The moment diagram for the entire frame is shown in Fig. 3.

As a second example consider the frame of Fig. 4. Here equal eccentric loads are applied at similar places on both columns, so that the frame and loading are symmetrical about a vertical center line. Eq. (1) to (4) applied here give the following values for the closed rectangular frame with eccentric loads on both columns:

$$M_{AB} = M_{BC} = -\frac{n}{a}\left(C_{AD}\,(n + 2p) + C_{DA}\,p\right)$$

$$M_{CD} = M_{DA} = -\frac{n}{a}\left(C_{AD} + C_{DA}\,(n + 2)\right)$$

With hinges at C and D all terms not containing the quantity p are neglected, and the above expressions reduce to

$$M_{AB} = M_{BC} = -\frac{n}{2n + 3}\left(2\,C_{AD} + C_{DA}\right)$$

$$M_{CD} = M_{DA} = 0.$$

For the dimensions given in Fig. 4, $n = 3$, $C_{DA} = -0.12\ Pe$ and $C_{AD} = 0.32\ Pe$. Hence the moment at A or B becomes $-0.173\ Pe$ and the moment diagram for the whole frame is as indicated in Fig. 4.

It is hoped that the analyses of these rather common types of frame here presented may be found useful; however, further than this it is desired to emphasize the fact that the analysis of any sort of frame or arch subjected to a single concentrated load may be readily extended to investigate the effect of applying a couple at the same point.

Imhoff Operation Simplified by Extra Drain —Unit Costs Given

IN THE circular Imhoff tank in a sewage plant recently completed for Montezuma, Iowa, operation is facilitated by the addition of a drain with the flow line at such an elevation that the sewage may be drawn readily below the slots in case it becomes necessary to work upon the walls of the settling chamber. The tank is 20 ft. in diameter and 29 ft. deep. Prof. J. H. Dunlap, of the State University of Iowa, designed the plant, and a description written by him appears in a recent issue of *The Transit*, published at the university. He states that in actual operation of tanks in towns of the size of Montezuma, about 1500, not infrequently the sedimentation chamber is allowed to become completely sludged up and thus transformed into a small septic tank. In order to clean out the sedimentation chamber it has been found necessary to lower the sewage below the slots and then force the sludge down through the slots, carefully squeegeeing the walls and aprons.

Some of the unit costs of the plant, based upon labor at $4 per day and teams at $7 per day of 10 hours (until late autumn, when the day was shortened to eight hours) are as given below. The haul of 1.3 miles was over a fair road, with no upgrades. The costs are as follows: Earth work by slip scrapers, 1060 yd. at 47c.; excavation for tank by hand before banks caved, 408 yd. at 82c., and after cave-in with bracing, same amount, $2.70; sodding berms of filters, 20½c. per square yard. The total cost per yard of the filter sand in place was $1.86 per ton, made up as follows: Cost, f.o.b. sand company's plants, 35.; freight, 90c.; unloading, mostly from box-cars, 6.3c.; hauling, 39c.; unloading from wagons, 2.2c.; leveling and spreading with a backfilling machine, 13.1c. The 1:2:4 concrete in place in the cylindrical walls of the tank cost $14.65 per yard. The distribution is as follows: Cement, 6.4 sacks f.o.b. Montezuma, at $2.28 per barrel, $3.65; hauling, $0.18; sand, 0.45 yd. at $2.65, $1.19; gravel, 0.9 yd. at $3.59, $3.23; reinforcement, $1.49; setting forms and reinforcing, $2.93; mixing and depositing, heating sand, gravel and water, $1.98.

Field Manual for the Idaho State Highway Department

IN BUILDING up a state highway organization in Idaho to meet more nearly the conditions imposed by the participation of the state in the benefits of the Federal-aid road act, and also to co-ordinate the work of the various engineers and employees, a field manual of regulations and procedure was issued July, 1919. It is in loose-leaf form, 3¾ x 6¾ in., and is used as a guide only, being subject to change as conditions are altered. The plan adopted for the administration of the Bureau of Highways, which is under the commissioner of public works, consists in the division of the state into seven districts, with each division engineer having charge of 3 to 10 counties. District offices are in Pocatello, Idaho Falls, Shoshone, Boise, Challis, Lewiston and Coeur d'Alene. The Boise office administration staff consists of the following eight departments, under Col. D. P. Olson, director of highways: Consulting engineer, chief clerk and assistants, accountant and assistants; office and road engineer handling surveys, a chief draftsman and his assistants, maps and blueprints, construction and resident engineers, bridge engineer, under whom are structural draftsmen and structural resident engineers; maintenance engineers; transportation engineer having charge of motor transportation and shops; educational: Instructions or orders emanating from any of these departments to the various employees relative to work under that particular department's supervision are considered as having come from the director.

Instructions in the manual, which is similar to that of the Iowa State Highway Department, are based on the principle that the district engineer is the most important link in the organization, connecting the general office with the actual engineering work in the field and the people of the state. Final actions of the department are governed largely by the recommendations of the district engineer, but the commissioner of public works and the director of highways review the district engineer's reports and recommendations and take final action.

The eight topics covered in the manual are: Reconnaissance survey, traffic count, detailed road survey, detailed bridge and culvert surveys; preparation of plans, letting contracts, construction, payments. Most of these subjects follow the practice used elsewhere, but from the topic drainage, which is covered quite completely, the following may be quoted: "It is a well known fact that no road is better than its foundation; therefore, if all instructions relative to the use of tile were compiled into a single sentence, it would read, 'In case of doubt, specify tile.'"

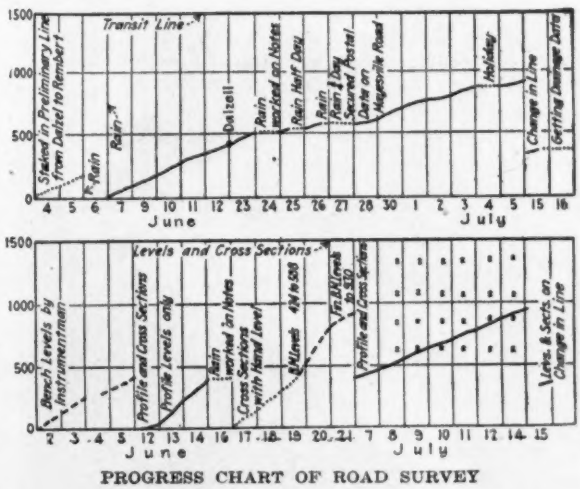
Construction work on each project is under the direct charge of a resident engineer reporting to the district engineer, who in turn reports to the construction engineer at headquarters. A statement of duties of the resident engineer normal to the position is made, and in addition the duties are summed up in the following paragraph: "The resident engineer must always remember that he is the man on the job and that he is primarily responsible for the proper execution of the work. He must be the eyes and ears of the Bureau of Highways and its various employees. He must make friends with the local officials and local people with whom he comes in contact. His value to the Bureau of Highways depends on his ability to get good work and leave no sore spots."

Under force account appears this statement: "Force-account work is one of the most fruitful sources of difficulty and disagreements between engineers and contractors. This disagreement can be largely avoided by keeping the records each day complete for that day's work. For this purpose a daily time report and a daily material report have been prepared. Each day the resident engineer or inspector will make out in duplicate the material and time reports for each force-account job separately. These sheets should be signed by both the resident engineer or inspector, and by the contractor or his representative, one copy being retained by each. Should the engineer's representative be unable to agree with the contractor on any point, notes stating the difference will be added on the reverse side of the sheet."

Graph Records Progress of Road-Survey Parties

By R. T. Brown
Chief of Surveys, South Carolina Highway Department, Columbia, S. C.

DAILY postcard reports sent in by chiefs of parties, and platted daily by an office clerk on the right-hand pages of a transit book, enable the chief of surveys of the South Carolina Department of Highways to check at a glance the progress of scattered survey parties. The postcards carry a printed form providing for the information wanted, so the data sent in by different parties are substantially the same in form and are easily deciphered for platting. On the transit-book plats, as shown by the accompanying example, each vertical space represents 100 stations, and each horizontal space represents one day. By means of these scales a fairly long survey can be platted on one sheet, and at the same time all the detail desired can be shown.



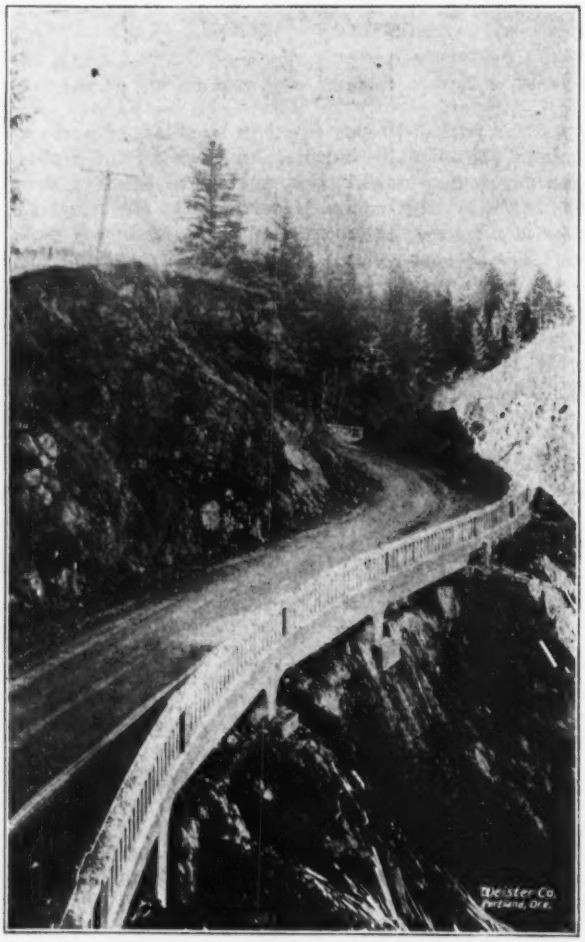
PROGRESS CHART OF ROAD SURVEY

The chart is helpful, not only in keeping in touch with the exact location of the party at any particular date, but also as an index to the ability of the party to do good work. An irregular graph with many breaks will often indicate a lack of familiarity on the part of the chief of party with the nature of the country, or poor judgment concerning desirable location.

The graphs are indexed and the cards are platted up each day by a girl in the office. The cards are filed in the desk of the chief of surveys, so that he may refer to the card for any day if the information on the graph is not sufficiently complete. After a use extending over many months, no need has been found for any more complex scheme of keeping up with the daily progress of the survey parties.

Concrete Structures Serve Double Purpose on Columbia Highway

THE Columbia Highway in Oregon for part of its length winds along the edge of cliffs of such nature that frequently some form of substantial guard rail is required. Bench cuts have to be made for the full width of roadbed desired; no advantage is gained from excavated material dumped at the outer edge because the slope is too steep to retain a filled shoulder.



HIGHWAY GUARD RAIL RETAINS FILL

As a result of these conditions two functions are occasionally combined in a single structure. The one shown in the illustration is typical. It consists of a "grasshopper" trestle carrying the outer 4 or 5 ft. of the roadway, thereby lessening the necessary width of cut by that amount, and at the same time its monolithic curbing, surmounted by a concrete balustrade, constitutes an effective and sightly guard rail.

Canada and United States Prepare St. Lawrence Development

Orders Are Issued to International Joint Commission To Make Study of Power and Navigation Possibilities of River

SURVEYS of the power and navigation possibilities of the St. Lawrence River between Lake Ontario and Montreal are to be begun immediately by the International Joint Commission by reference from the governments of the United States and Canada. Acting under instructions in last year's Rivers and Harbors Bill, the United States last year co-operated with the Canadian government in the study of the river to the extent of appointing Colonel C. Keller, Corps of Engineers, U. S. A., to act with W. J. Stewart, chief hydrographer of Canada, to prepare a set of questions which should be investigated before any definite steps toward development be taken. As a result of the joint work of these two engineers, the two governments have addressed a letter to the International Joint Commission asking it to take up the investigation of the project.

This letter, from Secretary of State Lansing, reads as follows:

I have the honor to inform you that the governments of the United States of America and of the Dominion of Canada, under the provisions of Article IX of the Treaty of the eleventh of January, 1909, between the governments of the United States and Great Britain, herewith refer certain questions, as set forth below involving the beneficial use of the waters of the St. Lawrence River, between Montreal and Lake Ontario, in the interests of both countries, and, in general, the rights, obligations, or interests of either in relation to the other, or to the inhabitants of the other along their common frontier.

It is desired that the said questions be made the basis of an investigation to be carried out by the International Joint Commission, to the end that the said commission may submit a report to the two countries covering the subject matter of this reference, together with such conclusions and recommendations as may be considered pertinent in the premises.

Question 1. What further improvement in the St. Lawrence River, between Montreal and Lake Ontario, is necessary to make the same navigable for deep draft vessels of either the lake or ocean-going type; what draft of water is recommended; and what is the estimated cost?

In answering this question the commission is requested to consider:

(a) Navigation interests alone, whether by the construction of locks and dams in the river; by side canals with the necessary locks; or by a combination of the two.

(b) The combination of navigation and power interests to obtain the greatest beneficial use of the waters of the river.

Question 2. Which of the schemes submitted by the Government or other engineers is preferred, and why?

Question 3. Under what general method of procedure and in what general order shall the various physical and administrative features of the improvement be carried out?

Question 4. Upon what basis shall the capital cost of the completed improvement be apportioned to each country?

Question 5. Upon what basis shall the costs of operation and maintenance be apportioned to each country?

Question 6. What method of control is recommended for the operation of the improved waterway to secure its most beneficial use?

Question 7. Will regulating Lake Ontario increase the low water flow in the St. Lawrence Ship Channel below Montreal? And if so, to what extent and at what additional cost?

Question 8. To what extent will the improvement develop the resources, commerce and industry of each country?

Question 9. What traffic, both incoming and outgoing, in kind and quantity, is likely to be carried upon the proposed route both at its inception and in the future? Consideration to be given not only to present conditions, but to probable changes therein resulting from the development of industrial activities due to availability of large quantities of hydraulic power?

Pending the receipt of plans, estimates and other engineering data necessary for the final consideration of this reference, the commission is requested to hold such public hearings as may be considered necessary or advisable in order to obtain all information bearing, directly or indirectly, on the physical, commercial and economic feasibility of the project as a whole.

To facilitate the preparation of the desired report each government will, from its official engineering personnel, appoint an engineer with full authority to confer with a similar officer of the other government for the purpose: First, of acquiring, each in his own country, such data as may be found necessary to supplement the existing engineering data and surveys and, second, of preparing complete outline plans for and estimates of the cost of the proposed improvement, including the value of all property, easements, damages and rights connected therewith. These plans and estimates are to be submitted to the commission as soon as practicable but not later than one year from the date of appointment and the commission is requested to forward to the two governments its final report with recommendation not later than three months thereafter.

Longest Concrete Arch Span Being Built at Minneapolis

400-Foot Span of Franklin Avenue Bridge Across Mississippi Surpasses By 62 Feet the Record Risorgimento Arch Across Tiber at Rome

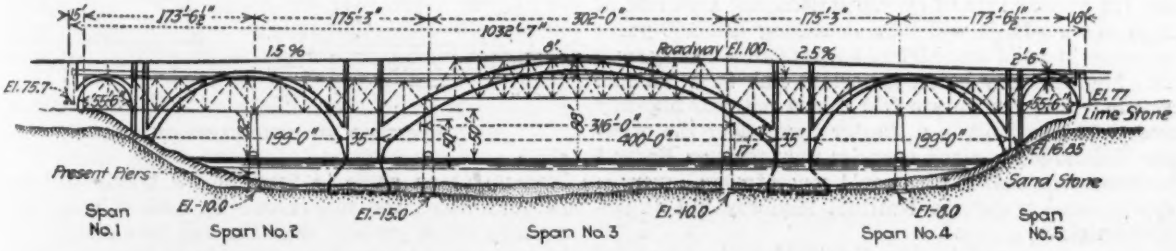
A 400-FOOT concrete arch, which will be the longest-span concrete arch in the world, is being built at Minneapolis, Minn., constituting the main portion of the Franklin Ave. bridge over the Mississippi. It will consist of two separate ribs of 400-ft. span between faces of piers, with a rise of 88 ft. above the springing line, at high-water level. The main arch is flanked at each end by one arch with a clear span of 199 ft. and one of 55½ ft., the total length of the bridge over abutments being 1032 ft. The piers will rest on the solid rock of the river bed. Each rib of the main arch will be 12 ft. wide, with a thickness of 17 ft. at the springing line and 8 ft. at the crown, carrying spandrel columns with cross-girders to support the concrete deck. The rib reinforcement consists of frames, 6 x 6 x ½-in. angles being used in the large span and smaller angles in the approach spans. The ribs are on either side of the present steel truss bridge, which thus affords facilities for the construction work. The 400-ft. span was necessary to give a clearance of 50 x 300 ft., as required by the United States Government for navigation purposes.

The present steel bridge is being used for traffic, as well as for construction purposes. Its roadway is 18 ft. wide, so that by the removal of the sidewalks the new arch ribs, placed 25 ft. apart, will clear the steel work, which will be removed when these ribs are completed, the floor for the 25-ft. space between them being placed after the removal of the old structure. This floor will be cast ashore and will be placed by a traveler from the completed floor over the arch ribs.

Work was commenced in June, 1919, on the work and concrete-mixing plant, located on the Chicago, Milwaukee & St. Paul R.R. tracks in southeast Minneapolis, about 2000 ft. from the east end of the bridge. The material will be handled by a conveyor system, and service between the bridge and the plant will be performed by two gasoline locomotives on a 36-in. track. This plant is nearly completed.

In July the cofferdam framing was commenced on a flat piece of river shore about one-half mile up the river from the bridge site. These frames were then floated down and placed in position for pier No. 1. This cofferdam will be 80 ft. up and down stream, and 64 ft. wide, divided into two compartments 40 x 64 ft., by 28-ft. 14-in. arched steel sheet piling, which also will surround the entire cofferdam. This pile driving has been completed for the downstream compartment. The piles are driven through boulders, gravel and limerock débris to and into the underlying sand rock. Excavation with a clamshell bucket was commenced before the pile driving was finished.

The general design of the bridge and the design of the great arch span were made by F. W. Cappelen, city engineer. The city is doing the construction by its own forces. Contracts have been let for the arch reinforcement. The construction of falsework for arch No. 2 has been commenced, and it is planned to work through the winter. It is expected that the bridge will be completed in 1921 at a cost of about $500,000.



FRANKLIN AVENUE BRIDGE ACROSS THE MISSISSIPPI AT MINNEAPOLIS WITH 400-FOOT REINFORCED-CONCRETE CENTRAL ARCH

Premixing No Benefit in Concrete

To determine the benefit of mixing cement and water for a long period (15 to 30 minutes), and then adding aggregates to produce a concrete instead of the ordinary method of mixing cement, aggregate and water together for one or two minutes, comparative tests were made last year by the United States Bureau of Standards. The strengths obtained were about the same with the same materials and conditions, indicating that there is no advantage in long premixing of cement and water.

Why Federal Aid Will Not Build a National Highway System

IN a recent address in Richmond, Va., H. G. Shirley, secretary Federal Highway Council, told his auditors that only through some such legislation as the National Highway Act now pending before Congress could the United States hope for a thoroughly national system of highways. He offered no disparagement to the operation of the Federal-aid Act, and he even encouraged its application wherever possible, but he asserted that it so operated that all Federal-aid money could easily be absorbed in the construction of widely separated road segments, and that even after years of construction of Federal-aid projects the states would be spotted with and not linked by Federally constructed highways. The most pertinent portions of his address follow:

"Let us review what is being done under the Federal-aid Act. In analyzing this work I do not want to be considered as criticising anyone, for I am a great believer in the good that this law has done and believe it should be continued for a decade, or at least until all the highway departments of this country have been put on a firm and substantial foundation with a sufficient appropriation to do the work necessary to be done in each state.

"After the passage of the Federal-aid Act the Secretary of Agriculture demanded that each state submit a map showing the system of roads selected to be improved under this act. Each state highway department compiled and submitted maps showing the systems for which it would ask aid and upon which it would submit projects to be approved. The system laid out in some of the states has been strictly adhered to and is being built in continuity, while in others the allotments have been divided up among the different counties of the states in the same ratio as it is apportioned by the National Government to the states. In one state I happen to recall that the allotment to one county, due to its small road mileage and population, amounted to only $4,000. Under the present rate of appropriations and high cost of improved roads, it will take something like 100 years or more to build one highway across this county, and this highway may be an important link in a national system. And yet we are told that a national highway system can be built in a shorter time under the existing Federal-aid law and agencies than under a Federal highway commission, who would concentrate all moneys appropriated under the National Highway bill on national highways.

"Let us now examine the distribution, the type, and character of the roads that are being built. We find in many states, as just above outlined, they are dropped around in the different counties where pressure is being brought on the state highway departments by the people of the different counties to have a piece of road, and they are compelled to bow to this great demand. As long as the county and state put up a portion of the money, just so long will they demand a voice in where this money shall be spent and upon the roads selected.

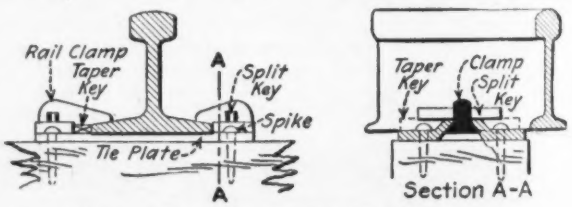
"Every man believes that the road running in front of his door or property is the most important road in the whole country, and to him I grant it is true. The records will also show that at least 66 per cent of the roads now being constructed under Federal aid are plain macadam or a lower type, and not of sufficient stability to meet the traffic needs of a national highway system. Many are only being graded and drained. I do not want to be understood as criticising, but I am only laying these facts before you so that you may determine in your own mind whether, under existing laws and conditions, this country can have constructed in the most expeditious and economical way, a national system of highways. I believe from an educational standpoint that the Federal-aid money has been of great value and it behooves you to see that in the future it is expended in the very best way and that it secures for you the very best results obtainable.

"The mileage on national systems is but a small part of the total mileage necessary in each state to take care of its transportation needs and to develop the state as a whole. Therefore, it is the duty of the state to provide ways and means for caring for a large mileage of state roads. Roughly speaking, that mileage should be between 4,000 and 5,000 mi. built into a state system, and at least 7,000 or 8,000 mi. built into an improved county system. A few national highways would form a backbone to which the state could connect and co-ordinate its system, with the county, connecting its system with the states and extending out into the farming communities like the spokes of a wheel, touching every farm. This is a general plan of roads and should be the ultimate aim of the nation, the states and the counties."

Clamp Fastening for Track Rails

A RAIL fastening now in experimental use employs clamps and keys to secure the rail to a tie-plate and maintain a tight grip. Spikes are used only to secure the plate to the tie, in order to avoid removal of spikes when rails are renewed or shifted to maintain gage.

As shown in the accompanying drawing, the tie-plate is slotted at each end, the sides of the slots being



RAIL SECURED TO TIE-PLATE BY CLAMPS

bent up at an angle to form hollow triangular ribs, between which the rail rests. On each side is fitted a clamp which projects over the rail base and has its lower part of triangular section to fit into the hollow rib of the plate. A split key driven through the clamp holds it in place, these keys projecting over the spike heads, thus preventing the spikes from working loose. The space between the ribs is wider than the rail base and a flat taper key is driven on one side to hold the rail laterally and also to prevent it from creeping. These keys are placed normally on the inside of the track, but as the gage is widened by rail wear the keys on one rail can be transferred to the outer side, to permit the rail being shifted inward to maintain gage.

This device is made by the Railway Safety Tie Co., Milwaukee, Wis., and has been in use over 12 months on a few rail lengths of both the Chicago & Northwestern R.R. and the Chicago, Milwaukee & St. Paul R.R. Both locations are on curves, and the former road reports that the fastening has reduced the amount of maintenance work.

Construction Work on an Outlet Sewer in Soft Soil

EXCAVATION, followed closely by concreting and backfilling, together with pulling of the forms in 12 hours and an advance of 35 ft. of 8-ft. sewer in 24 hours, were characteristics of the construction of the combined outlet sewer and storm water conduit at Granite City, Ill. This is a concrete structure, 7 miles in length, having an internal diameter of 9 ft. to 4½ ft., while the exterior has a flat base and vertical sides up to the level of the springing line of the arch. Work was commenced at the 9-ft. outfall, which was in low swampy ground, where considerable quicksand was encountered and the bottom of the cut was in 2½ ft. of water, requiring heavy pumping. Farther back the excavation was in firm alluvial soil and sand overlaid by clay soil which stood at fairly steep slopes. The depth of cut ranged from 15 ft. to 22 ft. and at one point tunneling was employed in passing under a group of railway tracks on a fill.

Both excavation and backfilling were done by a 1-yd. grab bucket handled by a 15-ton revolving locomotive crane having a 50-ft. boom and mounted on a pair of four-wheel trucks. This machine traveled on a standard-gage track laid parallel with the work Ordinarily the backfilling was done at night, but any spare time during the day was utilized for this work. Two dipper excavators mounted on a wide track of 12-ft. gage were used at first, but were replaced by the more powerful machine with grab bucket.

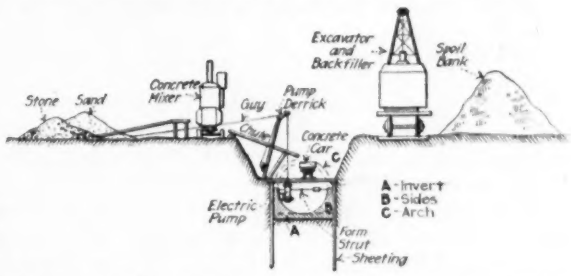
In good top ground only the lower part of the cut was sheeted, using a single line of 2 x 12-in. plank driven by hand hammers assisted by water jets and sunk to depths varying from 8 to 14 ft. according to the soil and ground-water conditions. Below the water line the joints were covered by batten strips 1 x 6 in. The waling timber on the side opposite the excavator served to support a mason's derrick from which a trench pump was extended. The head of the derrick was attached to guy cables led back to deadmen or other convenient anchors at the surface of the ground, while a bracket or gooseneck on the derrick extended the hoisting line so as to avoid lowering the derrick to an undesirable angle.

A steam pump was used at first, but was replaced by an electrically operated unit which was more convenient and eliminated the trouble of continually adjusting a suction pipe. This unit consisted of a centrifugal pump with 6-in. suction and having a vertical shaft carrying a 25-hp. motor, the whole being mounted in a steel frame about 6 ft. high, which was suspended from the derrick and could be raised and lowered by the hand hoist. The total weight of this unit was about 1500 lb.

In the sandy subsoil the bottom of the cut was leveled readily by two or three men with shovels as the water was removed, the elevation being checked by sounding with a level rod. The bottom level of concrete, however, was deposited without waiting for the base to be entirely dry. The work was done in lengths of 35 ft., the farther end being closed by a plank bulkhead with the top of the concrete floor.

A concrete mixer of the gravity type was used at the outfall. This had a batch capacity of ½-yd. and required a height of about 14 ft. but was practicable here on account of the depth of cut being about 16 ft. After the depth was reduced to about 13 ft. a ½-yd. steam-driven drum mixer was used, the frame carrying boiler and machine being mounted on traction wheels. This moved along the side of the cut opposite the excavator.

Cross timbers laid upon the waling timbers supported lengths of 2-ft. portable track made with rails and ties bolted together. This was at the middle of the trench and on it traveled a ½-yd. steel car with tilting and dump body, the body revolving on a turntable so as to dump in any direction. Concrete was spouted into this car from the mixer on top of the bank. Three men then ran it forward, dumped and returned it; a fourth man swept loose concrete off the track, shifted the dumping timber along the rails and held the level rod for checking the elevation of the concrete base. This process was repeated until the concrete reached the bulkhead at the end of the 35-ft. section.



TYPICAL ARRANGEMENT OF CONSTRUCTION PLANT FOR OUTLET SEWER AT GRANITE CITY, ILL.

The next step was to pull forward the 35 ft. length of the semicircular steel bottom form, sliding it on the concrete base. For this purpose the excavator was moved up to the head of the new section and secured to the track by clamps. Its bucket was removed and the hoisting cable was lowered into the trench, being passed around a snatch block hitched to a timber strut reinforced by horizontal kneebraces. The cable was led along the concrete floor and coupled to a pulling bridle a little distance back from the head of the form. The sides were loosened by drawing up the turnbuckles on the steel top struts of the form. With a steady pull on the cable, while men with bars raised the forward edge of the form, the 35-ft. length was started easily as a rule and was pulled forward for the next set up, the bottom elevation being then checked and the sides extended to the full diameter by the turnbuckles on the threaded struts.

Concreting of the sides, up to the springing line, was done with the equipment noted above, the car body being swung round so as to dump to either side. A wooden panel placed on the form struts to prevent concrete from being spilled inside the form was shifted ahead as the filling progressed. This concrete was stirred or rodded by two men with long bars, while a man with a hoe scraped the concrete from the splash panel.

The steel arch form of the completed section in the rear was then moved forward, but instead of being pulled bodily it was usually dismantled, the panels and ribs being removed and re-erected by hand. Although moved in about 12 hours after the concrete had been placed, there was no failure or sign of deflection on the arch.

Wood panels were used for outside form at the sides of the arch, the top being left open. Concrete was spouted into place from the mixer and spaded or rodded in the forms, while the top was finished almost flat. Rough spots caused by removal of the forms were plastered with cement mortar within an hour after such removal.

Stone concrete was used, 1:2½:5 made with 1½ in. coarse aggregate. Stone and sand were distributed by teams and wagons in stock piles along the line for a considerable distance ahead of the construction. As these materials were deposited on dry ground it is stated that the loss will be small and that the cost of planking for a base would have far exceeded the value in saving of material. In concreting, the skip was charged by wheelbarrows, the wheelers doing their own loading. This force averaged as follows: 1 man at skip hoist, 1 to supply water and dump the concrete, 1 or 2 men moving concrete down the chute with hoes, 4 supplying sand, 6 supplying stone, 1 emptying cement from sacks piled near the mixer.

At street crossings, traffic was diverted, but where there were car tracks a timber deck was placed, having stringers resting on mudsills and carrying the track ties. Excavation beneath this was then done by hand, the sides being sheeted to the top of the cut.

Work was carried on in two 10-hour shifts, but no concreting was done at night. Progress with the 8-ft. section has averaged a 35-ft. stretch of invert, sides and arch in 24 hours, this representing about 50 yd. of concrete. Electric current for lights and for the trench pump was taken from an adjacent overhead line, a portable substation being rigged up with two transformers mounted on a wagon. A switchboard for the pump was set upon the bank and moved ahead with the work. Portable carbic lights were also used.

The John T. Walbridge Engineering Co., Chicago, has the contract and the work is under the supervision of Mr. Walbridge or his superintendent, H. W. Costello. The engineers are Edmund Hall and W. W. Kerch of Granite City.

Kansas Intestinal Malady Probably Not Due to Water-Supply

THE recent outbreak of intestinal diseases in Kansas was not due to public water-supply, in the opinion of officials of the Kansas State Board of Health. The following summary and conclusions relating to the outbreak have been sent to *Engineering News-Record* by Chas. A. Haskins, engineer of the Division of Water and Sewage of the board:

A considerable number of cases of a strange malady diagnosed by many physicians as "winter cholera" has occurred in Kansas during the past three weeks. In some places the outbreak has been epidemic. In Topeka more than 1,000 cases were reported within three days to the health officer, but since it was not considered by physicians generally as influenza it was not handled as a reportable disease; consequently the State Board of Health records are by no means complete.

These cases occurred in cities and in the country where all sorts of sources of water-supply were in use, some of them known to be of good quality and others considered of doubtful quality. The Topeka water supply is not considered above suspicion, particularly in the few weeks preceding the epidemic, when a new connection to the Kansas River had been constructed with apparently inadequate means for its sterilization.

The disease was characterized as a gastro-intestinal disturbance and was accompanied by nausea, diarrhœa, pains in the stomach and similar symptoms, and was followed by aching joints and an extreme weariness and exhaustion. A careful study was made of feces, urine, and blood from a number of cases, but so far this has revealed no source of infection. No diagnosis has been offered by any competent person other than that of "winter cholera," although it has been called by many "intestinal influenza."

The opinion of the writer, which is also the opinion of the executive officer of the State Board of Health, is that this disease has not been proven to be waterborne, but it is believed that it may and probably is transmitted in this manner and also in other ways.

Favors Automatic Train Control on Heavy Traffic Lines

THE Automatic Control Committee of the United States Railroad Administration, in its report to the Director of the Division of Operation, recently made public, states that the use of train-control devices is desirable on lines of heavy traffic, fully equipped with automatic block signals, but that the relative merits of the various types of devices already tested cannot be conclusively determined until further tests have been made. The recommendation is also made that the work be continued under the direction of the American Railroad Association after the termination of Federal control.

The report points out that automatic devices will prevent only such accidents as are due to the failure of employees properly to observe signal indications, and that the limitations of such devices should be thoroughly understood. It is also stated that the cost of automatic train-control system is as yet unknown.

The train-control committee of the Railroad Administration was created in January, 1919, and has made detailed inspection of thirty-seven devices and examined plans for 300, of which but seventeen were found available for further tests. This followed the work of the Interstate Commerce Commission, which has continued since 1907, when an appropriation was made and investigation ordered by Congress.

Beet Pulp Disintegrates Concrete

Contact with beet pulp has a deleterious effect on concrete—this was shown recently in an examination made by a representative of *Engineering News-Record*. In Utah, near a beet-sugar factory, concrete roads over which pulp was hauled away by farmers showed severe pitting and wear. The spots, which were bunched toward the center of the road, had been tarred, and although the road was apparently fully repaired, close observation indicated that some action under the tar was still going on. It is possible that the spots examined may not have been thoroughly cleaned before the tar was applied. This was on the Ogden-Salt Lake road. Investigation was also made of a beet-pulp pit at Rupert, Idaho. Around the pit is a concrete curb from which a planked embankment rises. The edges of this curb have crumbled, and are rounded off to about 2-in. radius. The concrete was apparently of fair grade below that disintegrated.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Bridges and Gagings on the Rio Grande

Sir—Your attention is invited to a misstatement in an article by Alfred J. Henry, meteorologist, entitled "Floods in the Lower Rio Grande, in New Mexico and Texas," appearing in your issue of Dec. 11-18, 1919, p. 1001. The fifth paragraph says, in part: "There are no bridges across the Rio Grande below Laredo, and no permanent object on which to install a river gage, . . ."

The International Bridge across the Rio Grande at Brownsville, Tex., connecting Brownsville and Matamoros (Tamaulipas), was built in 1909-10 by the Gulf Coast Lines and National Railways of Mexico, jointly. It is located about 22 miles (in an air line) from the mouth of the Rio Grande and about ⅝ of a mile southwest of Brownsville. It is a combined highway and railway bridge, with a total length of about 620 ft., consisting of four Pratt trusses and two plate girders. The two center trusses are connected to form a swing bridge with two 125-ft. openings. The average height of the bridge is about 45 ft. above the river bottom, but the elevation of the latter varies as much as 10 ft. in flood seasons.

The Rio Grande Valley in the vicinity of Brownsville is subject to flood inundation every high water, and it would seem desirable to start continuous river gages at this point, if not already undertaken. The river channel, in the vicinity of the bridge, is confined to a fairly permanent location by a system of heavy brush mattresses weighted by flat concrete slabs of about 180 lb. each, and river gaging could be taken in such manner as to record the run-off very accurately.

BILLINGS WILSON,
Fort Sam Houston, Tex. Captain, Corps of Engineers.

[Mr. Henry's comments on Captain Wilson's letter follow.—EDITOR.]

Sir—The statement in my article in regard to bridges across the Rio Grande below Laredo had reference to that stretch of the river on which gagings would be helpful in predicting floods for the overflow region about Rio Grande City, Texas.

While gagings at Brownsville, made from the bridge mentioned by Captain Wilson, would be useful in many relations they would be of little value in the flood prediction work of the Weather Bureau for the region above-mentioned. ALFRED J. HENRY.
Washington, D. C.

Experiment Stations to Reduce City Risks

Sir—The recent discussions by engineers in *Engineering News-Record*, regarding the risks which cities should take with untried processes, are interesting in demonstrating the necessity for central testing stations, or possibly national evaluating committees, whose function should be the determination of the relative merits of suggested processes.

You will be interested in the discussion of the same problem abroad, which appeared in the inaugural address of Arthur J. Martin, president of the Association of Managers of Sewage Disposal Works. What he says on this subject is given in the last paragraph of his address. The entire address, entitled "Sewage Purification Problems," appeared in *The Surveyor and Municipal and County Engineer* for Dec. 19 and 26, 1919.

ABEL WOLMAN,
Division Engineer, Maryland Department of Health.
Baltimore, Md.

[Before quoting the above mentioned paragraph of Mr. Martin's address it may be said for the benefit of those who do not know that Mr. Martin is a member of the Institution of Civil Engineers and that he was one of the firm of Cameron, Commin & Martin, which promoted the Cameron septic tank in England. United States patents on the septic tank were issued to the three individuals composing the firm mentioned. The paragraph referred to reads:

Under normal conditions, the amount of money spent every year on works of sewage disposal is very considerable. There are many available methods for the engineer to choose from. He needs reliable information to guide his choice. And when he has selected his process he requires reliable data upon which to design his works. There are, doubtless, some adventurous souls quite willing to experiment with new processes at the expense and risk of their clients. But the great body of engineers are conservative, and are not disposed to gamble with their clients' money and their own reputations by the adoption of methods with regard to which there is the least uncertainty. And so, in default of reliable information concerning new processes, large sums of money are spent on lines which are admittedly not up-to-date, but which have, at all events, stood the test of time. A central testing station, at which new processes, precipitants, filtering materials, distributors, and all the other paraphernalia of sewage disposal, may be judged on their merits is urgently needed. If for any reason the Ministry of Health do not see their way to take the matter up, the Engineering Standards Committee, which has rendered such valuable services in other directions, might fitly undertake the duty, in which case the Government should recognize the national importance of the work by aiding it with a substantial grant.

It may well be asked if the time has not come when the Federal Government should take up sewage treatment investigations on a larger and more continuous plan than has yet been attempted, and if so to what existing or new branch of the Government the work should be entrusted.—EDITOR.]

Paint Experiences

Sir—The criticism, by A. H. Rhett, of the report on painting of the American Railway Bridge and Building Association, in your issue of Dec. 25, 1919, p. 1072, seems to the writer to be undeserved. It is, however, true that it should not be necessary, even near the coast, to repaint every year; the Florida East Coast R.R. engineers use paint which they make for themselves, chiefly of white lead and chrome yellow, which does not need renewal for three to five (and sometimes more) years, and other Southern lines find equally good results from red lead and lampblack. The writer has studied the one-year trouble on the spot, and is persuaded that it comes from using a not-very-good paint, which stands well enough in the dry air of the northern arid regions; but it will be found on more carefully looking into the matter than is possible from your brief abstract, that it is chiefly the surface coat which must be frequently renewed.

Failure of bituminous coatings (which in practice include coal tar as well as asphalt) depends on what they are made of. There is no reason why a good asphaltic paint could not be made, but it would probably be too expensive per square foot, applied. Black is the common finishing color, because it doesn't show dirt; not a very good reason, truly; but it protects the film from the chemical action of light (so do yellow, brown and red).

The engineers of the late Metropolitan Water and Sewerage Board (of Massachusetts) believe that paint exposed to water is injured by hydrolysis of the oil in the film; they combat this in several ways, but partly by using boiled linseed oil, which itself resists such action somewhat. The writer is in favor of using at least half boiled oil in bridge painting in very moist localities.

We shall never be through discussing the painting of galvanized iron. Letting all the zinc rust off is extreme treatment; usually the iron will be full of holes before that happens. But I can not agree with Mr. Rhett in thinking it as simple a problem as he supposes. Zinc, aluminum and copper are all difficult to paint. Sometimes the paint sticks, but it is unwise to guarantee that it will. True, such guarantees are often given, but generally they have holes in them, and they peel off when the paint does.

A. H. SABIN,
Consulting Chemist National Lead Co.
New York City.

How Shall the Co-operation of All Engineers Be Effected?

Sir—A debatable question no longer exists as to whether engineers of the country should get together in furtherance of their non-technical interests. The attitude everywhere is not whether, but how shall this end be achieved? Some engineers evidently think that a sort of super-organization of the founder societies should be brought into existence, or perhaps a federation of all societies, but an increasing number are coming to the conclusion that the end will be best accomplished by using the well tried machinery at hand, designed for this purpose, namely, that of the American Association of Engineers.

A striking omission occurs in the report of the Joint Conference Committee of the older societies, one which by its absence attracts comment throughout the rank and file of the profession, namely, the neglect to refer to the fact that the work proposed to be done has already been undertaken and is well advanced by the American Association of Engineers, with a membership now larger than that of any other national society. From all parts of the United States is coming the question, "Why has the Joint Conference Committee's report been silent on this vital question?"

In answer to this question and in the firm belief that the rank and file of the profession are waiting for such an announcement, the Secretary of the American Association of Engineers on Dec. 20, 1919, addressed the following letter to the governing bodies of the founder societies:

The development of the opinion in the founder societies in favor of giving attention to the non-technical side of the engineer's life has led several members of each to ask the American Association of Engineers to write simultaneously to the governing bodies of these societies offering its service in problems of public and professional welfare and asking their co-operation.

We have read the report of the Joint Conference Committee and believe that the American Association of Engineers, a successful going organization, is capable of carrying forward the non-technical activities recommended in the report fully as well and perhaps better than the organization recommended by the conference report.

The activities of A. A. E. are confined to social and economic problems such as legislation, employment, compensation, political and civic endeavor. A. A. E. takes in everyone of good character in the engineering profession and seeks to mobilize all engineers for joint action. It gets its support from the man back home without any intermediate representation so that it is able to do the things that lie close home and that make living as an engineer worth while.

If the founder societies elect to co-operate with A. A. E. in the work it is doing and in similar non-technical activities, it would be our understanding that such support would not be financial and would in no way interfere with present prerogatives and privileges of the founder societies.

This letter has been approved by our Executive Committee at its meeting Dec. 20, 1919. We are enclosing copy of our constitution for convenient reference.

Let us have full discussion. The great body of engineers who have given the matter thought evidently believe that the ends to be attained from the human side must be reached by a strong, well built and thoroughly democratic organization, devoted exclusively to these ends and organized for effective action in ways which the men of experience in human and political activities have found to be most effective. On the other hand, they feel that the purely scientific societies, organized for the investigation of natural phenomena and their application, which elect for their officers men distinguished by research and technical achievement, cannot by mere federation and delegation of power through complicated machinery achieve important results for the welfare of engineers as men and citizens.

Are you in favor of unity along the lines of the above letter? If so, write to the secretary of the national technical society of which you are a member, and to the secretary of the American Association of Engineers.

C. E. DRAYER,
Secretary American Association of Engineers.
Chicago.

Should Engineers Pay To Improve Their Status?

Sir—For some time past I have been very much interested in your articles and letters on "What Will Engineers Pay to Improve Their Status?" Is it possible to improve one's status by "pay"? Why not let us be honest with ourselves and change the title to "Why don't engineers so conduct themselves that their status needs no improvement?"

Railroad trainmen jokingly say that locomotive firemen have to keep their heads in the fire boxes for so long before they are promoted to engine drivers that by the time they are running engines, they have no brains left. Is it not true that most young engineers spend so much time on mathematics and pure and applied science, that by the time they reach a position of responsibility, their outlook on life is anything but liberal? Lawyers, doctors and clergymen pay nothing to improve their status. Their work just naturally broadens them and they command respect because they conduct themselves so as to deserve it. I am sorry that I cannot say as much for all engineers. Let me give a specific illustration.

Recently a young civil engineer of my acquaintance

accepted a position as structural designer in the construction department of the largest manufacturer of cheap automobiles in the United States. The construction work involved the expenditure of millions of dollars. On reporting for work he was given a badge, instructed how to punch a time clock, informed that working hours were 8 a.m. to 5 p.m. every weekday in the year and if one minute late, he would be "docked" fifteen minutes' pay, and that there would be no pay for sickness, holidays or vacation. The company ran a commissary. A dining room with table-cloths was used by the factory foremen, but the structural designer was conducted past this room to the cafeteria, where the laborers and general help dined. Having once been a private in the Army and being as democratic as the Salvation Army he enjoyed eating with the mob, but did not see how he could retain his self-respect and maintain the dignity of an engineer's position if he should continue to favor the cafeteria with his patronage—so he quit the same day he started. But the point is, he left a number of engineers on the job who were either too meek to demand better conditions or else didn't know any better.

The employing engineer in this case is an associate member of the American Society of Civil Engineers, so what is the use of talking of paying to improve the status of engineers when the employing engineers are seemingly indifferent to the conditions under which their men work, and who claim that for every man that leaves their employ they can find two others to take his place. It takes about a year to learn bricklaying and about ten years to master structural designing. A good bricklayer in Detroit can get $1.50 an hour or $12 per day. How many structural designers get $12 per day—Darn few!

High-sounding talk about "status" may be all right in its place, but "hand it" to the bricklayers for results.

Fordham, New York. M. KINCAID.

Method of Locating Split-Switch Turnouts

Sir—Referring to Mr. Scott's letter relative to laying out a split-switch turnout, in *Engineering News-Record*, Oct. 9, 1919, p. 711, I have the following comments to offer. As the degree of curve through the lead has no relation to a curve back of the heel of the frog, I can see no reason why, with a competent trackman, the engineer need pay much attention to any part of a common turnout except the location of the frog. In places where it is necessary to use lap-leads, or where a track crosses a turnout between the heel of the switch point and the toe of the frog, which is a common occurrence in terminals, it is absolutely necessary for the engineer to be able to determine the exact degree of curve of the turnout, in order to be able to figure the angles of the special frogs.

Since the curved part of the turnout is tangent to the heel of the switch point and the toe of the frog, it can readily be seen by the accompanying sketch that the exact degree of curve is determined from the six following dimensions: 1, thickness of the switch rail at the point, which is usually ¼ in.; 2, the length of the switch point; 3, the distance between gage lines at heel of switch point; 4, the gage of the track; 5, the length of the frog from theoretical point to toe; 6, the frog angle. A change in any one of these dimensions will change the degree of curve.

I find there are many engineers in railroad work who have never seen a solution of this problem and I give, therefore, the following, which is the one used in designing the special track work for the track elevation of the Indianapolis Union R.R. While there are other solutions, I believe this is as simple as any.

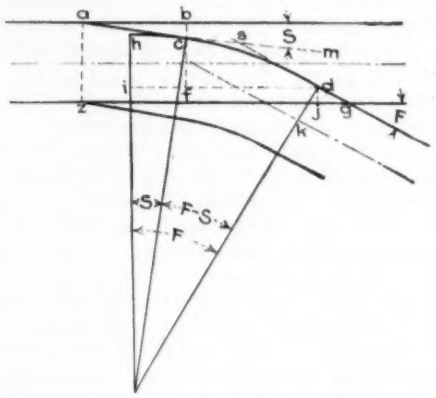


DIAGRAM FOR LOCATION OF TURNOUTS

G = Gage.
F = Frog angle.
S = Switch angle.
ac = Length of switch point.
bc = Distance between gage lines at heel of switch.
¼-in. = Width of point of switch rail.
dg = Length of frog from theoretical point to toe.
ek = Radius of center line of turnout.

To find ek and zg

With ed as a radius perpendicular to dg draw the arc dc tangent to ac at c and extend it to h, so that eh is perpendicular to the main track. Draw ce. Then deh equals F, the frog angle; and hec equals S, the switch angle. Then:

$$\frac{bc - \frac{1}{4}\text{ in.}}{ac} = \text{sin of switch angle or sin } S$$

$$dg \sin F = dj$$
$$F - S = ced$$
$$= msd$$
$$G - (bc + dj) = cf$$
$$ed \cos S - ed \cos F = cf$$
$$ed = \frac{cf}{\cos S - \cos F}$$

$$ed - \frac{G}{2} = ek$$

= radius of center line of turnout

$$ed \sin F - ed \sin S + dg \cos F + ac \cos S = zg$$

= length of turnout

L. E. RATCLIFF,
Indianapolis, Ind. Indianapolis Union R. R.

Co-operation in Highway Construction

Sir—No doubt the facts brought out by R. G. Collins, contracting engineer, Cumberland, Md., (in *Engineering News-Record*, Jan. 15, p. 122) will induce a sympathetic response from highway contractors. Highway engineering is not the most difficult of engineering practices, in consequence of which, perhaps, it has usually been an open field for the small as well as the big contractor. It appeals to some because the outlay for equipment is comparatively small. Other contractors who have recently entered the field have been attracted by the volume of work to be accomplished.

During the war the contracting field was rather barren of new projects and when this great volume of highway contracts developed, almost all contractors were very keen for new business and this great volume of proposed new construction proved very attractive.

It is true that a large number of contractors during the past year suffered losses due largely to weather conditions. This is where the element of chance enters the road-building game. The remedy cited by Mr. Collins, for shortage of labor and material, reduces to a minimum the loss in delays from tangible causes.

The inspection difficulties have always been an ever present cause of concern on almost all kinds of construction work. The effects are sometimes very disquieting, and this condition is attributable to the human element to a large extent. If there could be created a spirit of co-operation instead of antagonism between the states' representatives and the contractors' men the problem would be fairly well solved, and with this good purpose accomplished the benefit would accrue to the state and to the contractor. Should this state of affairs develop under private ownership work, the contractor would in a personal interview with his principal soon have the matter adjusted. Then, why not such relief in a public contract!

There are cases wherein contractors are operating at a loss due directly to the fact that, in computing costs, some essential and obvious features have been overlooked. In all contracts an investigation should be made of the local conditions which might affect the work—information as to permits, leases, rights of way, obstacles to be encountered, and remedies to be considered. Then, too, the complete plan of operation and layout must be well balanced and study made for proper and economical handling of the work.

If, however, a contractor has filed his proposal containing figures based upon an incomplete investigation of the proposed contract, there can be little relief from the results attending such optimism. On the other hand, if the results are adverse, due to conditions, abnormal beyond estimate, such as too rigid inspections and severe and impracticable detail requirements by the state department representatives, why not supply a remedy for this condition by instituting a clearing house for such contingencies? Let the contractors form a road contractors' association, with a definite purpose and method in view, and with proper representation at the seat of authority by one versed in the rights of the contractor and requirements of the state. There is little doubt that a measure of relief, substantially gratifying, would result. This is an occasion for initiative. Where are the contractors who feel it incumbent upon them! L. E. GASKINS,

Narberth, Pa. Cost Engineer.

Error of Approximate Method in Design of Eccentric Rivet Connections

Sir—I refer to the letter on "Eccentric Girder Connections" in your issue of Jan. 8, 1920, p. 99, and to the article on the same subject in your issue of Oct. 16, 1919, p. 730. In view of the disagreement of the two writers it is of interest to go further into the subject.

The following shows that the method offered by Mr. Godfrey is on the side of safety. It may properly be used when sufficient time is not available for more exact figures or where only a very small number of columns is involved. With a large number of columns the saving to be effected by the use of the more exact method is too great to be ignored.

For the extreme and simple case shown by Fig. 1 herewith, there can be no disagreement, and the stress on rivet *B*, as stated by Mr. Godfrey, is $S = Pb/a$. For the more usual case, shown by Fig. 2, it is clear that in order to carry the load there must be certain deformations of the rivets which will produce a very small rotation of the plate and bring the horizontal resistance of the rivets into play as well as their vertical resistance. For this reason the method offered by Mr. Carman is the correct and accurate one.

By Mr. Godfrey's method the stress for each of the eight rivets in the right-hand row is 5,000 lb. By the method of Mr. Carman the resultant stress on the two most highly stressed rivets, the top rivet and the bottom rivet in the right-hand row, is 3,330 lb. This shows that Mr. Godfrey's method, for this case, gives results 50 per cent above the true value, and that, if the allowable stress per rivet is 5,000 lb., the number of rivets and size of plate can be materially reduced. With six rivets per row spaced 3 in. center to center, the maximum resultant stress by the correct method will be so slightly over 5,000 lb. as to be acceptable. This means a saving in plate which is worth while if a large number of columns is involved.

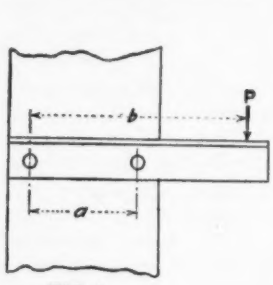


FIG. 1

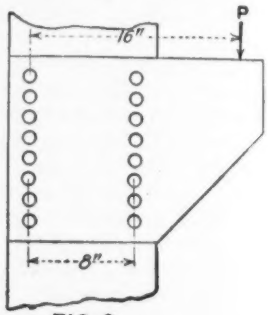


FIG. 2

If *a* be made 12 in. and *b* be made 24 in., the value obtained by Mr. Godfrey would still be 5,000 lb., while the exact method gives 4,040. It would be easy to suggest dimensions for which the error of Mr. Godfrey's method would be over 50 per cent.

Referring to Fig. 2 on page 99 of your issue of Jan. 8, 1920, and to the discussion: By Mr. Godfrey's method it would appear that the number of rivets in the left-hand row could be reduced without increasing the stress on the rivets in the right-hand row. This is not true. Using Mr. Godfrey's method for Fig. 2 herewith, the upward force on the left-hand row is $S = P\ (b - a)/a$, or 20,000 lb., requiring four rivets at 5,000 lb. each. But by the exact method, using the center of gravity of the rivet group, if the lower four rivets of the left-hand row are omitted, the most highly stressed rivet will receive a stress of 4,610 lb., as against 3,330 lb. as heretofore shown if the full number of eight rivets be retained. Since reducing the number of rivets in the left-hand row increases the labor of the calculations, the drafting expense and the shop expense, with an increase of rivet stress and only a small saving of scrap material, it is clear that the use of an equal number of rivets in each row is very much to be preferred.

WM. RUSSELL DAVIS,

Albany, N. Y. Consulting Engineer.

The Status of the Engineer

Sir—I was very much interested in the state of mind revealed in a letter written by J. L. Harrison appearing in *Engineering News-Record* of Dec. 25, p. 1070. It is just such thinking as he exhibited that was responsible for the needless coal strike, and the wasteful steel strike, and similar lack of vision will be responsible for a vast amount of unnecessary suffering in this country and elsewhere during the next few years.

Sooner or later the majority of thinking men will come to accept this principle: A man should be paid in proportion to his contribution to society. No pay for no work—more pay for more work—plenty of opportunity for all that care to work—these will solve much of our present industrial and social unrest. Most of us fail to realize that we all insist upon a living wage, and take it for granted that we earn what we get, whether we do or not. I know personally of one gang of men working for the Railroad Administration that is doing about two-thirds as much as before the war, and is receiving nearly three times as much in dollars. They are not earning what they are getting.

Mr. Harrison remarks that "a man must always use the tools with which he is familiar." We have penitentiaries established for men of a certain calling that get too familiar with the use of certain tools. This country recently sacrificed thousands of lives and billions of dollars because a Kaiser used the tools with which he was familiar. Neither a democracy, nor an autocracy, nor any other form of organization has by sole virtue of its methods of procedure the privilege to ride roughshod over the established rights of humanity. The union leader who demands a wage that is not earned is no less a plunderer than the thug with gun and blackjack. Both ask for what is not rightfully theirs to ask for, and are wiiling to use force to obtain it. That sort of spirit has bred terror and trouble throughout history.

What is vitally needed is recognition by each group of society, and each part of each group, of its relation to the rest of society. It must try, in a fair-minded, scientific fashion, in so far as this is possible, to discover what may rightfully be claimed as its share, and what must properly be given in exchange for that share. Unless the ideals of Justice, Co-operation, Energy, Economy and Service guide all of us in our efforts we shall eventually fail as surely as we must ever fail to change the fixed and immutable laws of Nature.

I do not wish to be misunderstood in regard to unionism. There are times and conditions under which unions serve a very useful and legitimate purpose. In the coal-mining industry the assurance of being able to express grievances, and the knowledge of having ample protection in regard to wages and conditions in all probability is worth many times to society the higher wage usually paid to union mine labor. There is very little question as to such lawful organization. On the other hand the shipyard workers' unions during the war, in hundreds of instances, developed an attitude of insatiable greed that approached outright treason. These are the extremes of unionism—the one unquestionably beneficent, the other positively dangerous. Where unions are beneficial to society they should be promoted, or the need for them removed. Where their action is harmful, they must be educated to change their ways, or be pitilessly crushed.

It remains to be seen whether the American Association of Engineers or the American Federation of Labor is to dominate the rank and file of the engineering profession. Unhesitatingly I cast my lot with the American Association of Engineers.

E. M. GOLDSTINE,
Junior Member, Am. Soc. C. E.

Terre Haute, Ind.

Moment Transfer in Eccentric Connections

Sir—Edward Godfrey's article, "Common Errors in Detailing Steelwork for Buildings," in your issue of Oct. 16, 1919, p. 730, has elicited so much adverse criticism that I wish to call attention to the truth in the statement under contention. In speaking of eccentric loads Mr. Godfrey states:

"It is better and more economical, however, to make the details such that the bending moment is thrown into

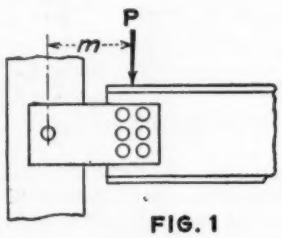


FIG. 1

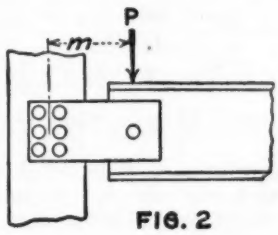


FIG. 2

the girder instead of the column. It may sound odd, or even improper to some minds, to speak of shifting moments around in this manner by mere altering of details, but to the writer's mind this is one of the very important facts of structural detail designing."

These are facts which frequently have to be impressed upon the minds of draftsmen and the only fault in Mr. Godfrey's logic is the selection of an unfortunate example. Herewith is a sketch which illustrates the theory. In the detail Fig. 1, the moment *Pm* is carried by the six rivets and the load on the support is all vertical with no bending moment in the column. In Fig. 2

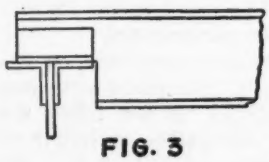


FIG. 3

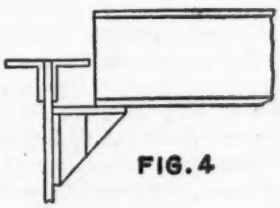


FIG. 4

the moment *Pm* is carried by the six rivets with an equal moment *Pm* in the column. Manifestly Fig. 1 is more economical in the design of the column and the moment may be transferred from beam to column, which proves Mr. Godfrey's statement quoted above.

To illustrate with a more practical example, two beam-seat details are shown in Figs. 3 and 4. The former is much superior to the latter, but such details as Fig. 4 are not at all unusual.

The truth which Mr. Godfrey has stated, but failed to prove, is hard enough to impress on the detailer's mind without being refuted by engineers of high standing. The critics should have been more careful to state that it was the example and not the theory to which they took exception.

T. S. NEEDELS.

Cleveland, Ohio.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Home-Made Device for Operating Slab-Finishing Belt

TIME and labor have been reduced in belt-finishing concrete pavement at Marshalltown, Iowa, by using the truss device indicated. The truss is white pine and is made up of 6-ft. sections bolted together, the number of sections used depending upon the width of the pavement. It is supported by two end posts which ride on rollers on the curbs. To the end posts are hinged bent levers *A*, *B*, *C* to the ends *C* of which are fastened the belt. Two men operate the belt, by pumping up and down the lever end *A*, with considerably

BELT OPERATED FROM TRUSS TRAVELING ON CURBS

greater ease, it is stated, than they can drag the belt back and forth by grasping the ends. It is also stated that the belting is more nearly uniform. The contractors for the pavement are the Carlson Construction Co., Marshalltown, Iowa.

Precautions in Grouting Tunnels and Shafts

PRECAUTIONS to be observed in placing grout as a means of backing up and filling spaces behind tunnel linings, cutting off flows of water into shafts and tunnels and solidifying dam foundations are set forth in a paper by James F. Sanborn, consulting engineer, New York City, and M. E. Zipser, of the New New York Board of Water Supply in a paper, "Grouting Operations, Catskill Water Supply," appearing on p. 3 of the January, 1920, *Proceedings* of the American Society of Civil Engineers. The grout on the Catskill work was generally injected by air pressure.

The experience in the grouting operations on the Catskill project, the authors state, showed that grouting is very effective for backing up and filling the spaces behind tunnel linings. A mixture consisting of 1 bag of cement, 1 bag of sand, and from 6 to 8 gal. of water, was found to be well adapted for this purpose. The air pressure should not be greater than is necessary to force the grout into place. An excess of air churns the mix, causing separation of the sand and cement. The pressure actually used varied from 30 to 90 lb. per square inch. To complete the filling of the voids between the tunnel lining and the rock, particularly in the high places in the roof adjacent to the vent pipes, air pressure up to 300 lb. per square inch and neat cement grout were used.

Good results were obtained in cutting off the leakage of water into the tunnels by grouting the water-bearing seams. For this purpose, it is essential to control the inflowing water by collecting it behind drip-pans or a steel shell, and draining it by pipes through which the grout is subsequently forced into the seams. Neat cement grout, about 6 gal. of water to 1 bag of cement, was found to be effective for this purpose. For fine openings a very thick mix must be used in order to obtain good results. The pressure should be sufficient to overcome the ground-water head and force the grout into the rock.

In sinking wet shafts, grouting was successful in cutting off leakage. The best results were obtained by alternately drilling and grouting, using holes about 10 to 15 ft. deep in the bottom of the shaft. The consistency of the grout should be adjusted to the size of the seams. In some cases, a little addition of bran, oats, etc., to the neat cement grout will aid in plugging the crevices in the rock.

The results obtained in treating the foundations of dams and in cutting off leakage underneath the dikes by drilling holes and grouting the rock seams under the dam structures were satisfactory. It is desirable in such cases to explore the rock under the dams thoroughly by diamond-drill borings for the purpose of locating weak zones and open seams. The location of the holes and method of grouting will depend on the natural conditions encountered.

The procedure to be adopted in any grouting operation must take into account all the factors that enter into the problem. No one method is applicable to all cases. The conditions encountered during the grouting may make it advisable to modify the procedure materially. Good judgment and skillful adaptation to meet varying conditions are essential to success.

To avoid the after-blast of air when grouting a space filled with water it was the usual practice to close the discharge valve before the hose "kicked," the latter requiring careful watching. A further precaution used to prevent the separation of the mix, where a large space filled with water was grouted, was to keep the grouting connection from 2 to 3 ft. below the top of the grout.

Tractor Aids in Cellar Excavation

BY C. S. BENNETT
Dayton, Ohio

ON A RECENT housing project at Dayton, Ohio, a number of small one-story cottages were to be built, each with a cellar. The contractor, finding teams scarce at the time the work had to be done, and having a small gasoline farm tractor at hand, decided to try out the tractor as an excavator. The tractor was one of the caterpillar-tread type and one of the smallest on the market. An ordinary drag scraper was attached to the tractor, and after the first earth for each excavation was loosened with picks, the outfit went to work.

The dimensions of each excavation were about 20 x 20 x 5 ft., and the tractor operator had no difficulty in getting into and out of the pit. Two men in the pit kept the earth loosened with picks. Over twenty cellar excavations were made with this outfit on this job, and it was done at a considerable saving over the use of one or more teams. G. W. Schartzer & Co., Dayton, Ohio, were the contractors.

NEWS OF THE WEEK

New York, February 12, 1920

Virtual Agreement on Rail Bill Reported

Conferees Adopt Chief Features of House Bill But Senate Rate Rule Principle Is Retained

That a virtual agreement had been reached by the joint conference committee of Congress in formulating a report on the two railroad bills was indicated in reports from Washington last week. The main features of the Esch bill have evidently prevailed but the principle of the Senate rule for rate-making and the distribution of excess earnings was retained as a temporary arrangement for one or two years following the transition period. While the details of the agreement have not been made known up to this writing, it is expected that the report of the conference committee will go to Congress within a week.

Statements made by the conferees and reports from Washington indicate that the agreement embodies the features which are presented in the following paragraphs.

Return of properties to owners under supervision of Interstate Commerce Commission, with increased membership and broadened powers, but with no provision for a Transportation Board as provided in the Senate bill.

GUARANTEE 5½% NET

A rate rule that is a virtual guarantee of 5½ per cent net income on "value of property," with the length of time it shall remain in effect undecided. For six months following return of roads, present Government rental is guaranteed. The Commission may allow one-half of 1 per cent above 5½ per cent for additions and betterments not to be included in capital account.

The Commission is directed to prepare a new rate schedule sufficient to produce the 5½ per cent return and "excess" earnings are to be divided equally between the carriers and the Government instead of a larger proportion going to the Government, under certain conditions, as required in the Senate bill. For six months after the return of the roads state commissions will not be permitted to suspend intrastate rates previously fixed by the Railroad Administration.

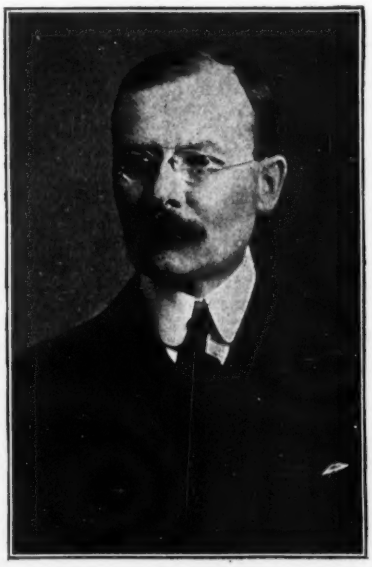
The anti-strike provisions of the Senate bill requiring compulsory arbitration are dropped in favor of a plan for establishing regional boards and an appeal board of five members whose appointment is approved by the Senate. The only appeal from the board's findings is through a strike or lockout, but there are definite provisions for publicity and discussion.

Elected President Engineering Institute of Canada

R. A. Ross, member of the Administrative Commission of the City of Montreal, has been elected president of the Engineering Institute of Canada.

Mr. Ross was born at Woodstock, Ont., and was graduated from the University of Toronto with degrees in both mechanical and electrical engineering. His work, practically all of it in a consulting capacity, has been chiefly along electrical lines. He has been retained by such important interests as the Hydro-Electric Commission of Ontario, the Canadian Pacific Ry. and by some of the larger cities in eastern Canada. He has given courses at McGill University, and his lectures have also been put into book form under the title "Engineering Economics."

Elected President Engineering Institute of Canada



R. A. Ross

Los Angeles Union Terminal

The Railroad Commission of California has just issued a report on its investigation of grade-crossings and a union terminal in Los Angeles. In the main its recommendations are that most of the grade-crossings be eliminated; that a union passenger terminal be built on what is known as the "Plaza" site; that a union freight yard be provided and that a subway and elevated line be built to the depot at Sixth and Main Streets.

No Blame Fixed in Montreal Water-Works Strike

Commission Takes Testimony on Walkout of Union Plant Employees Which Cut Off City Supply

No responsibility for the strike of pumping station employees at the Montreal water-works on Jan. 1, 1920, is fixed in the report of the commission to investigate the subject appointed by the Provincial Government of Quebec. Instead the commission, in its report of Jan. 29, merely reviews the testimony brought out in the three-day hearing on the subject. The testimony of witnesses in the investigations brought out the history of a union labor strike which at midnight Dec. 31 left a city of 750,000 people, whose normal water consumption is 67,000,000 gal., to the prospective suffering and disaster contained in dead pumps and empty reservoirs.

With water low in the reservoir and pumping equipment in bad condition, fires were banked by the strikers at 10 p.m. Dec. 31 and at 12 o'clock the pumps were shut down and the men left their stations without having informed him of their intent, according to the testimony of E. R. Decary, chairman of the Provincial Administrative Commission, charged with the management of the water-supply system.

ENGINEERS HELP START PUMPS

Through the aid of the Harbor Commission, the Canadian Pacific Ry. and members of the Engineering Institute of Canada and other organizations, some of the city's nine pumps were gradually got back into service during New Year's Day. At 2 p.m. Jan. 1 the first pump, of 12,000,000-gal. capacity, was started and an hour and a half later the second pump of the same capacity was placed in operation. At 11:00 p.m. a 30,000,000 turbine pump had been repaired and placed in operation.

Other pumps were started later on and at the end of the second day of the strike the city mains were receiving water at the rate of between 62,000,000 and 65,000,000 gal., which approximates the normal consumption of the city. This, however, only supplied the mains from which it was drawn directly by the consumers, and the people on the higher levels were not supplied with water by the city plants for nearly a week. These elevated districts are served by two reservoirs, one considerably higher than the other. The water in the lower reservoir was 15 ft. deep Jan. 8, and pumping to the higher reservoir was commenced on that date. Thence the water situation returned to a normal status.

The strikers, who were members of Local 593, International Union of Steam and Operating Engineers, had been under a contract with the city governing wages and hours for the year 1919. In July, 1919, negotiations were begun for a 1920 contract. The men asked for an increase over the 1919 scale but no agreement was reached and the matter seems to have been dropped until November. Early in December the two sides agreed to obtain figures on the prevailing rate of wages in Montreal and later the matter was taken up for the city by officials and others who were engaged on a civil service plan. On Dec. 29 or 30, the exact date being in question, the two sides got together and the representatives of the city presented a wage scale said to be based on prevailing rates in Montreal and to be in advance of the 1919 schedule. The employees were not satisfied. E. R. Decary, chairman of the Administrative Commission, told the representatives of the employees that the wage experts for the city would submit their data to the men, and that the men might have the month of January to consider the scale and to submit data; and that if the men established, to the satisfaction of the commission, that higher wages should be paid than were offered then their schedule would be adopted, retroactive Jan. 1, 1920. The men said they would submit the proposition to their principals. On Dec. 31, the men came forward with two wage schedules of private concerns in Montreal, higher than what the city had offered but lower than what the men had demanded. The conference broke up without agreement on the afternoon of Dec. 31 and at midnight following the men went out.

Subsequent to the strike there was much local discussion as to which side was to blame, and some talk of mediation. The Administrative Commission had been created a year or two ago by the Provincial Government. The mayor and council, which had been left with but little power, have attributed the strike to the commission. Hence the Government investigation to fix the blame—and a report which merely summarizes the evidence.

Syracuse Sewage Works Report Goes to Consulting Engineers

Final recommendations for a sewage disposal plant for Syracuse, N. Y., have been made by Glenn D. Holmes, chief engineer Intercepting Sewer Board, and H. C. Allen, city engineer. They have been referred by the board to Metcalf & Eddy, consulting engineers, Boston, Mass., for opinion.

Army Tractors for State Roads

The Secretary of War is authorized, in his discretion, by a bill introduced by Senator Swanson of Virginia to loan to any state 5 and 10-ton artillery tractors for use in highway construction. The bill provides for state payment of repair and upkeep.

Canadian Government Outlines Good Roads Policy

Plans are being perfected for carrying out the good roads policy of the Canadian Government, involving the expenditure within five years of the grant of $20,000,000 voted by the Canadian Parliament. The grant is made, provided the provinces do their share by contributing 60 per cent of the total. The relative grants to the provinces, calculated on the basis of population and the amount which each will have to contribute to obtain the Dominion grant, are as follows:

	Federal Grant	Required of Province
Alberta	$1,477,810	$2,216,715
British Columbia	1,251,955	1,877,932
Manitoba	1,602,265	2,403,397
New Brunswick	1,168,845	1,745,767
Nova Scotia	1,468,720	2,203,080
Ontario	5,877,275	8,815,912
Quebec	4,748,420	7,122,630
Prince Edward Island	603,455	905,182
Saskatchewan	1,806,255	2,709,382

The Maritime Provinces and the Western Provinces have yet to be heard from. Preliminary plans are being received from Ontario and Quebec, those of the former including a highway from Windsor to the Quebec boundary with a branch from Prescott to Ottawa. The projected works of the Quebec government comprise roads from Hull to Montreal and from Montreal to Levis, Sherbrooke, Riviere du Loup and the New Brunswick border. The grants will be made and the work directed by the Department of Railways and Canals, with A. W. Campbell as highway commissioner. Regulations governing the expenditures have been drawn up by an honorary advisory commission.

Construction Service and Engineer Corps in Army Bill Draft

The Army Reorganization Bill drafted by the Committee on Military Affairs of the Senate has been reported to the Senate. The bill as reported by the subcommittee to the full committee contains this provision with regard to the construction service:

"There is hereby established a Construction Service which, under regulations to be established by the President and in accordance with the provisions of this Act, shall be charged with the construction, maintenance and repair of all buildings, structures (other than fortifications), and utilities, and the preparation of plans therefor in accordance with the requirements of the several arms, corps and services of the Army of the United States, and with the operation of such utilities as the President may direct, and with the acquirement of real estate and the issuance of licenses in connection with military reservations under the jurisdiction of the War Department.

"The permanent personnel of the Construction Service shall consist of one chief of construction, with the rank of Brigadier General, and two hundred officers, in grades from Second Lieutenant to Colonel, inclusive, and six thousand enlisted men in their appropriate grades, all of whom shall be detailed or assigned from the permanent personnel under the provisions of this Act. The reserve personnel of the Construction Service shall consist of all reserve officers and reservists assigned thereto as provided for in this Act."

In regard to the Corps of Engineers the bill contains the following:

"The permanent personnel of the Corps of Engineers shall consist of one chief of Engineers with the rank of Major General and 1,100 officers and 16,000 enlisted men, in their appropriate grades, all of whom shall be detailed or assigned from the permanent personnel as provided for in this Act. The reserve personnel shall consist of all reserve officers and reservists of the organized reserves and the National Guard of the United States assigned to Engineer Corps Units as provided for in this Act."

The reserve personnel is to include reserve officers, reservists and recruits. The reserve officers are to include all persons who on the date of the passage of the Act hold commissions or appointments in the Reserve Officers Corps or in the National Guard and such other persons who shall be commissioned or appointed as provided by the new measure.

The reservists are those liable to further military training who have completed their prescribed period of initial training, and all other persons liable to military service in time of war who are not liable to training under the provisions of the Act.

Course in Management Engineering at Columbia University

Carrying with it the degree of Management Engineer, a new three-year course has been made available at Columbia University, according to the annual report of Dean George B. Pegram of the School of Mines, Engineering and Chemistry.

The new course is designed for men who desire to follow the business or administrative side of industry rather than the technical. In addition to the purely fundamental engineering subjects there will be included organization, management, economics, finance and labor relations.

Progress Toward Purchasing Toll Bridges

Valuation of the toll bridges of the Delaware River between New York and Pennsylvania having been carried out, a bill has been introduced in the New York Legislature to appropriate $125,000 for the state's share in purchasing four bridges, one at Port Jervis, Callicoon, Barryville and Narrowsburg. This is the beginning of state acquisition of the whole series of bridges, of which at present only one is a public bridge.

Iowa Has Primary Road Fund of More Than $5,000,000

Iowa had a net balance in her primary road fund of $5,046,770.36 Jan. 1, 1920. The primary road fund is composed of the proceeds of automobile registration fees and the state allotment of Federal-aid funds. The last Iowa general assembly established a system of roads, selected by county officials and the State Highway Commission, as a state primary road system. It comprises 6,400 miles of the main highways of the state and connects up every county-seat and every market place of 1,000 inhabitants or over. The primary road fund is set aside for expenditure on this system. Estimates made by the State Highway Commission are that by July 1 of this year the proceeds of the automobile fees and the Federal-aid allotment becomes available will probably double the present balance of $5,000,000.

City Planning Commission Created for Kansas City, Mo.

A city planning commission of eight members has been appointed at Kansas City, Mo. Among the members are Louis R. Ash, of Howard, Harrington & Ash, consulting engineers. Mr. Ash was recently city manager of Wichita, Kan., and has been city engineer of Kansas City. The commission is authorized by ordinance to submit comprehensive plans for the development of the city, including street widening and extensions, river-front improvements and zoning. The ordinance under which the commission was appointed also provides for an advisory city planning board of ex-officio and other members, including the city engineer, now R. W. Waddell, and the landscape architect of the Park Department, now George W. Kessler, and in addition the members of the Board of Control of the Kansas City Railways Company.

Motion-Picture Publicity for Engineers

A co-operative arrangement has been made between the producers of several moving-picture weeklies and the American Association of Engineers, through which six screen weeklies will include engineering scenes or events likely to interest the public. The association is to furnish lists of timely engineering projects and works for this purpose, and asks the active assistance of engineers throughout the country toward making this arrangement work out successfully. Officials of corporations or construction companies who are doing or are having done construction work, or who have especially interesting machinery in process of installation, and all others having matter appropriate to this picture arrangement are requested to advise the office of the A. A. E., 63 E. Adams St., Chicago.

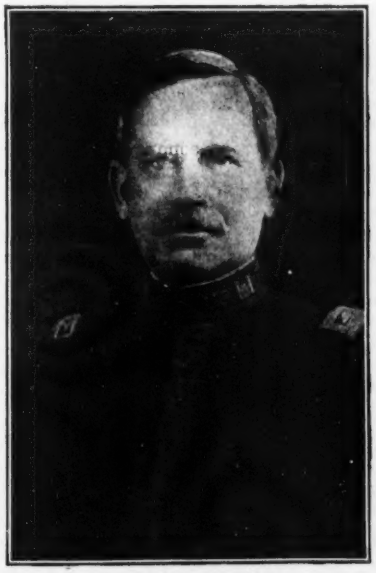
Gen. L. H. Beach Is New Chief of Engineers, U. S. A.

(Washington Correspondence)

Colonel Lansing H. Beach, Corps of Engineers became Major General, Chief of Engineers, U. S. Army, Feb. 4, 1920, when the Senate without delay confirmed his appointment by the President. The Senate's confirmation had been unanimously recommended by its Military Affairs Committee on the preceding day, as told in these columns last week.

By virtue of the appointment Colonel Beach automatically attains the rank of major general. He is commanding general of the Corps of Engineers and director of the Engineer Department. Major General Beach's military history was published in these columns Jan. 22, 1920.

Major General Lansing H. Beach Is Now Chief of Engineers U. S. Army



LANSING H. BEACH

The prompt confirmation of General Beach will have a decided bearing, it is believed, on the action of the Senate in connection with the River and Harbor Appropriation Bill. That bill was reduced far below the "irreducible minimum" fixed by Colonel Harry Taylor. Since General Beach is recognized as a river and harbor specialist, his opinion as to the action of the House in cutting the bill so drastically is expected to have important weight with the Senate committee.

Oregon Bill Aims at Patent Pavements

A bill has been introduced into the Oregon Senate making it unlawful for the state, any city or county, to pay royalties upon patent pavements, or patent pavement specification or design.

Chance for Success of $250,000,000 Reclamation Bond Issue Plea

(Washington Correspondence)

Despite opposition from some of the leaders in Congress to the proposed $250,000,000 bond issue for reclamation and irrigation projects in the West, there is a chance for the Westerners to succeed with their proposition. It is probable that the measure will have to be widened so as to include swamp and cut-over lands, but the fact that the West is now in the saddle in Congress and in addition occupies a strategic political position makes the chance for success good. The delegation from the West has succeeded in overturning a long-established precedence in resuming a hearing directly from the Steering Committee.

Already the Steering Committee has given decided encouragement to the proposed legislation, and, what is more, a vacancy on the Steering Committee probably will be filled by the appointment of Representative Nolan of California. This will give the West the control of that committee and its all-powerful influence for the bond-issue is regarded by many as certain. William Spry, former Governor of Utah and one of the Western delegation, pointed out to the Ways and Means Committee that the Reclamation Fund bond issue is a different proposition from appropriations for rivers and harbors. That money, as he stated, is not returned, while the bond money will be repaid with interest.

War Department Issues Commandeer Order for Rails

An order commandeering 72,500 tons of steel rails, for delivery by March 1 in addition to the 42,500 tons already contracted for by the Railroad Administration has been issued by the War Department, acting under war-time authority, at the request of the Railroad Administration. The order is to be filled by the Carnegie, Illinois, Bethlehem, and Tennessee Coal and Iron companies on the basis of productive capacity. The previous order of the Railroad Administration was given to the Lackawanna, Illinois, and Colorado Fuel and Iron companies.

It is reported that the War Department was asked to invoke its war-time powers and commandeer the rails because some of the so-called high cost steel companies were asking $57 or more for rails. The Railroad and War Departments are satisfied, it is said, that there can be no effective steps taken to prevent the War Department using its commandeering powers and then turn the rails over to the Railroad Administration unless it can be shown that the price finally offered by the War Department is unfair.

The new order is construed in some circles as a final act of the Railroad Administration toward making up the alleged serious deficiency in maintenance as to rail renewals.

Engineers of Three States Promote License Laws

Engineers in Kentucky, Ohio and West Virginia have recently taken action to bring much nearer the enactment of a license law in each of those states. The legislature of Kentucky is reported favorable to a license bill recently introduced under the auspices of A. A. E. members in Louisville. The bill is patterned after the Michigan law. At the recent meeting of the Ohio Engineering Society steps were taken to organize the engineers of the state to insure agreement among them on the desirability of a license law and to bring their influence on the next legislature.

The Ohio Engineering Society will appropriate a sum of money to start the campaign. The American Association of Engineers has agreed to appropriate an equal sum for license work in Ohio as soon as the Ohio Society announces the amount. The recently formed State Assembly of A. A. E. and the O. E. S. will co-operate fully in putting the license bill across. A joint committee of the two organizations will be appointed to map out a program and carry it through.

At a joint meeting of the West Virginia Engineers' Association and the Charleston Chapter of A. A. E. in Charleston, Jan. 23, licensing was discussed by Secretary Drayer of A. A. E., who recommended with minor changes the registration bill proposed by Engineering Council. After a lively discussion, a vote was taken showing the sentiment unanimous in favor of a license law in West Virginia. A motion was passed empowering the presidents of the West Virginia Engineers' Association and the Charleston Chapter to appoint a joint committee to prepare a bill for passage by the legislature which meets in 1921. A plan was outlined for interviewing every candidate for the legislature and for governor. Organization of the state will be by legislative districts.

Western Society Plans Work and Foresees Developments

Engineering development in its technical and broader social aspects was the theme of addresses at the annual dinner of the Western Society of Engineers, held in Chicago Jan. 28. In his address as retiring president A. S. Baldwin dealt with the relations of capital and labor in which the engineer is especially interested.

In the future, according to Mr. Baldwin, there will be a marked increase in the power of the great middle-class group in exercising control over the relatively small groups, capital and labor.

The society has trebled its membership by a campaign carried on in the great industrial center, Chicago, with over 6,000 engineers. Because of its large membership it was decided that the work of the directors must be decentralized and distributed more among the eight sections. Each of these, to a certain extent, is to become a self-contained society, but all co-operating as parts of the main body. If each section were the local branch of that national society with which most of its members are affiliated, and if each national body would in turn act as father of the section, it was considered that there would be a resultant strengthening of the sections, the Western Society of Engineers and the national societies.

Lines of future activity for the Society were traced by F. K. Copeland, the incoming president. Three such lines were given as technical development, civic development and social relations. In the second he included such matters as city planning, zoning and railway terminals, all of which he maintained can be handled most effectively by an engineering organization. While the Society's activities have hitherto been confined closely to technical matters and its work has been left largely to the officers, he intimated that the scope would be broadened and more of the work put upon the members.

Major-General Leonard Wood, U. S. A., spoke of the engineer as an aid in colonial development. Under his administration in Cuba an independent department of public works was formed and worked under a budget, which system he thought could be applied to advantage in this country. He emphasized the importance of the work of the engineer in the great war and advocated retaining the engineer officers' reserve corps as a factor in a program of preparedness for the future.

The officers for 1920 include the following: President, F. K. Copeland; vice presidents, C. F. W. Felt, J. L. Hecht and Linn White; treasurer, F. F. Fowle; secretary, Edgar Nethercut.

Expect Argentine to Bid on Entire Rail Surplus

It is understood that the Argentine Republic will bid on the entire amount of 32,000 tons of rail, declared surplus by the army, and soon to be offered for sale. That Argentina is contemplating considerable railway construction may be indicated by the fact that a New York firm is now carrying on negotiations with the office of the Director of Sales of the War Department looking to the purchase of the entire amount for that country. The quantity now held surplus includes 28,800 tons of 80-lb. drilled rails, smaller quantities of 100-lb. rails, 67½-lb. Russian rails and 30-lb. rails.

Canadian Construction Industries Favor Standard Contract

As a result of recommendations made at a recent session of the Association of Canadian Building and Construction Industries, the Royal Architectural Institute of Canada and the Engineering Institute of Canada will be asked to join the Association in drawing up a standard form of contract which may be used throughout the Dominion.

Mississippi Valley States Discuss Concrete Roads

Disapproval of any plans by which a Federal highway commission may build roads without state co-operation was registered by formal resolution at the annual meeting of the Association of Mississippi Valley State Highway Departments held in Chicago on Feb. 2-4, 1920. Annual appropriations of Federal funds for road building at the rate of $100,000,000, for four years, 1920-1923, were urged. A decided stand was taken against propaganda being "carried on by the American Automobile Association and other motor interests" to lower motor vehicle license fees, "regardless of circumstances existing in several states in regard to financing necessary highway improvements." Frank Rogers, state highway commissioner, Lansing, Mich., was elected president of the association for 1920 and Alex. W. Graham, state highway engineer, Jefferson City, Mo., was elected secretary.

Two full sessions of the meeting on the third day were thrown open to contractors, materials men and machinery men for a general discussion and exchange of opinion on concrete road construction. Out of the contradictory opinions voiced, the following conclusions appear to be justified: (1) Central mixing plants and wet haulage methods are increasing in favor; (2) heavy rolling of subgrade is a practice which is decreasing in favor; (3) bulk cement is successful where proper equipment is installed to handle it; (4) success in motor truck haulage is determined by road conditions; (5) heavy trucks are being replaced by light trucks with pneumatic tires; (6) aggregate storage practice leans toward tunnels or traveling bins; (7) generally greater weight and durability is necessary in road building equipment; (8) balanced plant requires more careful study.

Materials supply proved the most interesting subject of discussion. Of nine states represented in the association only one, Illinois, is furnishing any construction materials and that state furnishes cement only. The attitude of the contractors present was generally against state-furnished materials unless the states should also guarantee the contractors' losses due to interruption of work from lack of materials delivered. It was pointed out by the highway officials in their turn that unless better co-ordination could be secured between producers and contractors in keeping up the supply of materials for road construction, the states would as a measure of self-defense be compelled to assume entire control of the task. All states except one in the association plan this year to pay for materials delivered on the job, and properly stored for future work.

To Vote on $24,000,000 Bond Issue at St. Louis, Mo.

After a long period of deliberation during which the subject was considered by a special commission the city authorities of St. Louis, Mo., have formulated a $24,000,000 program of public works construction and have passed an ordinance calling for a bond election on May 11 to vote separately on each of these 18 propositions:

1.	Bridges and viaducts.....	$905,000
2.	New parks and playgrounds	1,385,500
3.	Improvement of existing parks and playgrounds...	1,174,500
4.	Municipal auditorium and community center building	900,000
5.	Sewer construction	2,575,000
6.	Improvement of the River des Peres	9,000,000
7.	Municipal farm for the care of delinquents	400,000
8.	Farm for the treatment of the tubercular and insane	1,100,000
9.	Additional West Approach of Municipal Bridge	1,500,000
10.	Construction of Municipal Dock near Victor St., including construction of railroad yards	1,700,000
11.	City's share of opening and widening streets	1,250,000
12.	Fire engine houses and equipment	360,000
13.	New buildings in Bellefontaine Industrial Farm for Boys	156,000
14.	Additional jail cells.....	76,000
15.	Construction of new morgue	68,000
16.	Municipal garage	90,000
17.	Maintenance of streets as general thoroughfares ...	360,000
18.	Electric lighting system in streets and parks.....	1,000,000
	Total	$24,000,000

A two-thirds majority of all the votes cast is required to carry any of the items. If the bonds are voted considerable time will be required to issue them and to pass individual ordinances authorizing the letting of contracts, so it is unlikely that any of the money will be available for expenditure before September.

The Board of Estimate has announced that an advisory committee of citizens would be appointed to assist in passing on the character of the expenditures under this bond issue. This committee will consist of one representative each from the Chamber of Commerce, the Buildings Trades Council, Manufacturers' Association, St. Louis Bar Association, Central Trades and Labor Council, Real Estate Exchange, and Merchants Exchange. This committee is not mentioned in the ordinance and will have no official status, but has been suggested in order to give the citizens at large a more direct interest in the expenditure.

Potomac Key Bridge Provided for in Deficiency Bill

Only after prolonged discussion was it possible to include in the second deficiency bill the $150,000 appropriation to make possible the continuance of the work on the Key bridge over the Potomac at Washington. The item was challenged on the ground that it was not a deficiency, to which Chairman Good of the committee replied: "It is a deficiency. We already have appropriated the full amount of the authorized cost, $1,000,000; but the bridge has not been completed. One million dollars was authorized before the war. The Interstate and Foreign Commerce Committee has reported out a bill to increase the limit of cost to $2,100,000. A bill of that kind will have to pass. This small appropriation is made in anticipation of that bill passing, and in order to prevent cessation of work."

Philadelphia Asks Bids on Street Improvements

Work valued at approximately $952,000 has been advertised by the bureau of highways of the Philadelphia Department of Public Works. The work includes asphalt paving and repaving, redressed granite block repaving, wood block repaving, the improvement of Adams Ave., the improvement to certain country roads and curb and footway work.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE; Feb. 16, 17, 18, Chicago.

NATIONAL CONFERENCE ON CONCRETE HOUSE CONSTRUCTION; Secretary A. J. R. Curtis, 111 West Washington St., Chicago; Feb. 17, 18, 19, Chicago.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA; 111 W. Washington St., Chicago; Feb. 18-19, Chicago.

AMERICAN CONCRETE PIPE ASSOCIATION; 210 South La Salle St., Chicago; Feb. 20-21, Chicago.

AMERICAN RAILWAY ENGINEERING ASSOCIATION; 1426 Manhattan Bldg., Chicago; March 16-18, Chicago.

AMERICAN ASSOCIATION OF ENGINEERS; 29 S. La Salle St., Chicago; May 10, 11, St. Louis, Mo.

The Richmond Chapter, A. A. E. met in Richmond, Va., Feb. 2. Many members from Norfolk and Lynchburg, Va., attended. The meeting was addressed by Representative Stuart of Virginia, who explained the Engineers' License Bill introduced by him in the state assembly. Following his talk the members passed a resolution indorsing his bill.

The Engineers' Club of Columbus (Ohio) at its meeting Jan. 30 was asked by the Mayor of Columbus to lend its assistance in civic affairs. The Mayor asked the co-operation of members in order to give the best possible service to the citizens.

The Engineers' Club of Seattle has elected for the ensuing year: J. Thomas Dovey, president; B. D. Dean, vice-president; A. L. Valentine, secretary; Amos Slater, treasurer.

The Cleveland Engineering Society, the Akron Engineering Society and the Cleveland Section of the Am. Soc., M. E. held a joint meeting in Akron, Ohio, Jan. 27. Many of that city's industrial plants were inspected during the meeting. A discussion of "Human Nature in Industry" was the feature of the session.

The Utah Chapter, A. A. E., recently elected: W. A. Richmond, president; W. A. Alexander, vice-president; Joseph Blickensderfer, secretary; G. A. McIntyre, treasurer.

The Iowa Engineering Society annual convention will be held Feb. 18 and 19 at Fort Dodge, Iowa. One of the main topics of discussion will be the consolidation of all of the engineering organizations in the State making the State Society a central body and the local sections its components. At a conference Jan. 8 a plan was outlined by representatives of several Iowa organizations by which greater service to the State, the profession and the individual engineer could be obtained. Districts would be established, according to the plan, and all members assigned thereto in accord with a method to be worked out after a study of the distribution of the engineering population.

The Vermont Society of Engineers will hold its next convention in Burlington, Vt., March 10, 1920.

The Engineering Society of Western Massachusetts met in Springfield, Mass., Jan. 20. The meeting included an inspection of the Springfield Gas Light Co.'s plant, a dinner and an evening session whereat two addresses on gas production were made.

The Rochester Engineering Society met Feb. 6 in Rochester, N. Y., and heard a paper on the commercial uses of tar by C. S. Reeve, formerly in the National Office of Public Roads.

The North Carolina Society of Civil Engineers held its annual meeting on Jan. 31. The members discussed a proposed amalgamation with the American Association of Engineers. R. C. Bailey, Washington, D. C., district secretary of the national organization, addressed the body.

The officers of the society are: Dr. W. C. Riddick, Raleigh, president, and Ira Mullins, of Monroe, secretary and treasurer.

The Connecticut Society of Engineers will hold its annual meeting in Hartford, Conn., Feb. 17 and 18. Papers on various subjects of state interest will be read by the following: Albert N. Turner, Dr. F. B. Jewett, James Handy, F. Irving Rudd, Frank Bachman, James E. MacElroy, and H. J. Hoard.

The Engineers' Society of Western Pennsylvania at its annual meeting in Pittsburgh, Jan 20, elected the following new officers: William Chauncey Hawley, president; Henry Duvall James, vice-president, and Arnold Stucki, treasurer. W. E. Fohl and J. H. Minton were chosen directors.

The Idaho Chapter, A. A. E., was organized Jan. 12 in Pocatello, Idaho. Following are the officers elected: E. D. Darlington, Jerome, president; Dr. C. N. Little, Moscow, first vice-president; E. S. Moberly, Pocatello, second vice-president; Capt. E. G. Ayres, Boise, secretary and treasurer. Those appointed to the executive committee are: J. H. Wilson, Idaho Falls; Barry Dibble, Burley, and Allen C. Merritt, Salmon.

The American Society of Civil Engineers held a regular business meeting Feb. 4 in the Engineering Societies Building, New York City. This was the society's first regular meeting since the annual meeting Jan. 21, 22. The speaker was James F. Sanborn and his subject, "Grouting Operations, Catskill Water Supply." Lantern slides were used in illustration of his talk.

The Engineers' Society of Northwestern Pennsylvania held its 23rd annual dinner meeting in Scranton, Pa., Feb. 4.

The Oil City Chapter of the A. A. E. elected the following officers for 1920 at its first annual meeting held in Pittsburgh Jan. 20: President, R. A. Harbaugh; first vice-president, B. B. Weber; second vice-president, C. L. Olmstead; secretary, A. C. Burwell; treasurer, S. L. Connell. Dr. F. H. Newell, president of the A.A.E., visited the Oil City Chapter on Jan. 2 and addressed a public meeting under the auspices of the chapter on "The Engineer and Good Roads." The chapter is said to be growing rapidly and now has more than fifty members. It has jurisdiction over five adjacent counties in northwestern Pennsylvania.

The Fairmont (W. Va.) Chapter, A. A. E., was organized Jan. 29, when the following temporary officers were elected: R. S. Quick, president; William Brassack, vice-president; H. F. Carr, secretary and treasurer.

The Connecticut Association of Members of the American Society of Civil Engineers held a luncheon meeting in Hartford, Conn., Jan. 30. C. E. Ewell addressed the gathering on "Water and Rail Transportation as Regulated by Public Utility Commissions." Another address was that of R. J. Ross, assistant city engineer of Hartford on "Assessments for Municipal Improvements." The program for future meetings, with speakers and subjects, is as follows:

Feb. 14, New Haven, S. E. Backes and C. J. Bennett, "Steam Railroads and River Navigation;" "Highways and Freight Carrying."

Feb. 28, Hartford, H. W. Griswold and R. N. Clark, "River Improvement and Navigation;" "Waterfront Improvement in Hartford."

March 13, Hartford, W. R. Dunham, Jr., "Relation of Electric Roads to Navigation."

March 27, New Haven, Charles R. Harte, "Different Forms of Contracts in Relation to Construction."

April 10, New Haven, R. J. Ross.

PERSONAL NOTES

KARL RIDDLE has been appointed resident engineer of the Federal aid road work in Dickinson Co., Kan., with headquarters at Abilene. He was formerly county engineer of Dickinson Co.

D. E. GILMER, president of the Southwestern Engineering Co., of Hutchinson Co., Kan., has been appointed county engineer of Reno Co., Kan., to succeed W. B. Harris who has resigned to go into private practice.

H. A. MARSHALL has been appointed first assistant engnieer of the Kansas State Highway Commission.

WILBUR L. FULTON, consulting engineer in structural steel and reinforced concrete, has opened an office for practice in Omaha, Neb.

E. W. BALDWIN has established a consulting office in Tulsa, Okla. Mr. Baldwin has practiced civil engineering in Michigan, Panama and Chile.

FRANK S. ALTMAN and G. W. BRANCH have been engaged by the Portland Cement Association and assigned territories in Kansas. Both were captains of Engineers in the A. E. F., Mr. Altman being in the 23rd Engineers and Mr. Branch with the 15th Engineers.

HJALMAR E. SKOUGOR has returned to private practice as consulting industrial engineer with office in New York City after severing his connection with Guggenheim Bros., Chile Exploration Co. and the Braden Copper Co. He had been designing engineer for those ccmpanies for the past seven years.

GILBERT H. PRATT has been appointed acting district sales representative of the Wallace & Tiernan Co. for New York, New England and northern New Jersey in the absence in Europe of A. M. E. Johnstone. After several years with the Massachusetts Health Department Mr. Pratt became chief of the Rhode Island State Department of Health and later chief chemist of the New York Continental Jewel Filtration Co.

A. L. MERCER has tendered his resignation from the position of assistant director of sales of the War Department in order to become president of the Needham Tire Co., Charles River, Mass. The company manufactures tires, soles and heels, and expects to manufacture a complete line of rubber goods for all purposes. Mr. Mercer took up his active duties as president of the company about Feb. 1.

HOWARD F. REED has reopened an office for the practice of engnieering in Phoenix in association with Sheldon K. Baker. Mr. Reed has only recently secured his release from the U. S. Army wherein he served as a Captain of Engineers.

LEWIS E. ASHBAUGH, hydraulic engineer with the J. G. White companies and clients for the past twelve years, has become connected with John R. Proctor, Inc., of Bayonne, N. J., and New York City. Mr. Ashbaugh is to be the sales-engineer at the New York office, in charge of installations of fuel-oil apparatus and other electrical equipment for power and lighting purposes.

H. S. MULLICAN recently resigned as county engineer of Davidson Co., N. C., to become consulting engineer on hard surface road construction and location revisions in that county. Mr. Mullican has been engaged in highway engineering in North Carolina for ten years.

W. R. HOLWAY has resigned as sanitary engineer in the Department of Water and Sewers at Tulsa, Okla., and has organized the Holway Engineering Co. in Tulsa. He is a graduate of the Massachusetts Institute of Technology. He has been assistant engineer for the Providence Water Supply Board, sanitary engineer for Alliance, Ohio, and for the past two years at Tulsa. The new company will specialize in water and sewerage work.

CHARLES R. WATERS has been promoted from the position of assistant engineer to that of chief clerk and engineering assistant in the New York State Engineer's Department at Albany. Mr. Waters, who has been employed in the department more than twelve years, has had wide experience in field construction, having been engineer-in-charge of some of the largest contracts on the New York Barge Canal. During 1918 Mr. Waters was private secretary to State Engineer Frank M. Williams, and since the promotion of R. G. Finch from chief clerk to deputy state engineer in January, 1919, Mr. Waters has been acting in the position to which he now receives permanent appointment.

GEORGE E. MARTIN, associate professor of highway engineering, Purdue University, has resigned, effective Feb. 1. Professor Martin graduated from the School of Civil Engineering, Purdue University, in 1909. In 1914 he returned to Purdue to take charge of the newly organized work in highway engineering and left again in October, 1917, to serve as a captain in the 23rd Engineers until July 2, 1919. He returned to the university in September, 1919. Professor Martin has become consulting highway engineer for the Barrett Co., with headquarters in Chicago.

CHARLES SAVILLE, civil engineer, has been made secretary of the Dallas, Tex., Chamber of Commerce.

T. MCLEAN JASPER, engineer with J. L. Jacobs & Co., Chicago, has become assistant professor of mathematics, department of engineering, University of Wisconsin. He was captain in the British Royal Field Artillery for four years of the great war, acting suc-

cessively as demolition officer, gun pit construction officer and battery officer in France. In England at the artillery officers' training school he was instructor in gunnery, demolitions and telephony, and later in London he was production officer in the fabrication of Imber non-explosive tanks. Prior to his service in the B. E. F. Mr. Jasper spent two years with Alvord & Burdick, consulting engineers, Chicago, and two years as secretary-engineer of the Chicago city water commission.

LESLIE H. BELKNAP has been appointed chief engineer of the Michigan State Highway Department succeeding W. W. Cox who has become highway engineer of St. Clair County, as previously noted in these columns. Mr. Belknap has served as district and division engineer of the department for six years.

JAMES L. DOYLE is engaged as valuation engineer in the appraisal of buildings of the Penn Public Service Corp. and the Centre & Clearfield Ry. Co. with headquarters at Johnstown, Pa. Leaving an engineering position with the New York State Public Service Commission, Mr. Doyle served in France as First Lieutenant, 102nd Engineers.

JAMES D. SCRUGGS has been appointed district manager and placed in charge of the new office opened in Birmingham, Ala., by the Richardson-Phenix Co., lubrication engineers and manufacturers, of Milwaukee, Wis.

J. H. COLEY, for the past seven years employed by the Geo. D. Whitcomb Co., as sales manager, has severed that connection to consider other matters inviting his attention.

H. L. HOOK, former assistant engineer for the Idaho Irrigation Co., has accepted a position with the National Carbon Co., Cleveland, Ohio.

H. C. BARNES, steel-treating expert, has joined the Allegheny Gear Works at Pittsburgh as superintendent of laboratory and metallurgical work.

JOHN A. STEVENS, whose engineering firm has headquarters at Lowell, Mass., and branches at Akron and Cleveland, Ohio, has established another branch in Fall River, Mass., to handle business in southern New England. Carl J. Sittinger will be in charge at Fall River. Besides handling power, power plants, and steam and electrical work for a large number of textile and other plants throughout the country, the firm has done a great deal of research work during the past ten years along the line of developing large and special boilers and assisting in developing turbines.

FRANK T. TOWNSEND, previously associate editor of *Engineering News-Record*, has become head of the department of civil engineering, Extension Division, United Y. M. C. A. Schools, New York City.

HAROLD ALMERT has been endorsed by the Chicago Chapter, A. A. E., as a candidate for the position of chief engineer of Chicago's traction commission.

L. B. HITCHCOCK, city engineer of Phoenix, Ariz., has been elected president of the Phoenix Chapter of the A. A. E. D. A. McClung, assistant county engineer, is secretary.

OBITUARY

FREDERICK HOLBROOK, president of the Grace-American International Corporation, of New York, died in Paris, France, on Feb. 6. Mr. Holbrook was best known as a member of the contracting firm of Holbrook, Cabot & Rollins, which he helped to found over 20 years ago. In 1916 he became a vice-president of the American International Corporation, in special charge of the Russian end of that company's business and was in Russia from September, 1916, to August, 1917. In March, 1918, he became president of the American International Shipbuilding Corporation which built and operated the famous Hog Island shipyard and remained in that position until 1919 when he became president of the Grace-American International Corporation, which was formed to do a Russian export business. Mr. Holbrook sailed for Russia in December, 1919, but never got beyond Paris. He was born in Lynn, Mass., July 20, 1861, and started in the contracting business through early training in railway engineering in the Far West where he was sent for his health when quite a young man.

THEODORE B. FORD, former member of the Connecticut Public Utilities Commission, died at his home in Bridgeport, Feb. 2, at the age of 51 years.

D. C. BARD, consulting geologist, of Seattle, Wash., died in Butte, Mont., recently.

E. T. WALSH, former major Ordnance Corps, U. S. A., and associated, in various engineering capacities, with the Interborough Rapid Transit Co., of New York City; Frederick Waldron Co., Plainfield, N. J.; and the National Cash Register Co., died recently at his home in Plainfield.

GEORGE E. BLAKESLEE, member of the New Jersey State Highway Commission, died recently after a short illness.

JOHN W. WILCOX, city engineer of Macon, Ga., for 16 years, died recently at Saluda, N. C. During his tenure of office which began in 1894 he undertook many improvements, notable among which was the sewer system, which has gained prominence because of the excellence of its construction.

R. H. CHAPMAN, topographic engineer of Washington, D. C., died recently in New York City while attending a meeting of the American Alpine Club. He had done notable work while in the U. S. Geologic Survey. He was a member of various technical and social clubs of Washington.

GEORGE WESTON, former city representative on the board of supervising engineers of Chicago street railways, and a traction pioneer, died suddenly in Philadelphia recently, aged 58 years.

E. F. WOOD, consulting engineer, New York City, died recently at the age of 60 years. He was formerly connected with the Carnegie Steel Co. and the International Nickel Co.

PROF. CHARLES D. BRAY, for 39 years in the mechanical and engineering departments of Tufts College, died recently of pneumonia. He was a member of several engineering societies and had served on various public commissions besides attending to his duties at Tufts.

BUSINESS NOTES

M. S. ROBERTS, JR., J. C. AKERS, F. E. FREELAND, J. R. CURREY, JR., AND W. H. LEVINE have incorporated in Tennessee the Freeland, Roberts Co., with a capital stock of $25,000, to engage in general contracting in Nashville, Tenn.

I. F. BAKER of the Westinghouse Electric International Co., who has been located in the New York City office of that company for the past two years, is now on his way to Tokio, Japan, where he will act as a special representative of the company.

E. H. PETERS has assumed the management of a new office in Chicago, opened for carrying on the business in that section of the Ideal Engine Co. and the Ideal Power Lawn Mower Co.

F. W. PROBST has entered the service of the Kansas City branch of the Barrett Co., to take charge of the field work in the western part of Missouri.

J. B. JOHNSTON, formerly manager of the ordnance department, Crucible Steel Co. of America, Harrison, N. J., has been appointed general manager of the Standard Scale & Supply Co., Pittsburgh, Pa., manufacturers of concrete mixers and other contractors' equipment.

THE SULLIVAN MACHINERY CO. announces the following appointments made by the Board of Directors: Arthur E. Blackwood, formerly manager of the New York City office, to be vice-president in charge of finance and accounting; Howard T Walsh, vice-president in charge of sales; Gilbert K. Wilson, assistant secretary in charge of cost accounting Nathaniel H. Blatchford, Jr., assistant treasurer; Emil A. Krevis, general auditor; Frederick W. Copeland, manager of foreign sales; Louis R. Chadwick, formerly Spokane, Wash., office

manager, New York City office manager; Robert T. Banks, for several years sales engineer in the company's office at El Paso, Tex., manager of the Spokane office.

L. BASSETT, WILLIAM F. MURPHY AND H. J. O'KEEFE have incorporated the Submarine Engineering & Construction Co. of Troy, N. Y. The purpose of the company is river improvements, and its capital stock is $50,000.

RICHARD F. JONES, M. STEPHEN DONOHUE AND FRANCIS E. JONES have incorporated in Connecticut the R. F. Jones Co. of Hartford, Conn., to engage in building erection. The company's capitalization is placed at $50,000.

F. H. MYERS, formerly an assistant secretary of the A. A. E., is now associated with the Certain-teed Products Corporation as sales engineer. Mr. Myers has spent almost two years at the national headquarters of the association, much of which time was devoted to building up the employment service. Prior to his connection with the A. A. E., Mr. Myers was with the Minneapolis & St. Louis Ry.

Spring Prices in New York

Brick and Lumber at Startling Levels—Concreting Materials Fairly Steady—Situation Complicated

By ALDEN W. WELCH

Prices of construction materials have been advancing since 1916, retarded only by the Government regulations, now removed. The advance continues and indicates higher prices in the coming spring. Herewith are two tabulations, the smaller showing the swift upward sweep of lumber prices, the larger giving the range of eleven materials in New York City. The figures are for April, May and June, 1913 to 1919, with the spring averages for each year and the prices quoted today.

BRICK, LUMBER AND CAST-IRON PIPE

The most startling jump was in common brick, lumber and cast-iron pipe. In the spring of 1914, brick sold for $5.50 per 1,000 alongside docks. This was an unusually low price, $6 to $7 being considered as fair. The price today, however, is $25 alongside dock, or $30.45 delivered in Manhattan. There are so many uncertainties in the trade that nobody is willing to hazard a guess as to the price of brick in the spring. In fact the companies are not quoting for future deliveries.

The following tells the story:

ROUGH YELLOW PINE, 20 FT. AND UNDER

	3x4@8x8	4x20@20x20
June, 1916	$27 50	$40 00
June, 1918	37 25	55 25
Feb., 1920	58 00	96 00

There is shortly to be a heavy demand for wooden piles. It is estimated that 75,000 will be required for pier work by New York City, the Cunard Steamship Co. and the Lehigh Valley R.R. Naturally a sharp price rise is expected.

Cast-iron pipe is another item that is particularly remarkable on account of its price altitude. In June, 1915, 6-in. cast-iron pipe cost $20 per ton; today $67.30 is quoted.

Cement has increased only 77 per cent since 1913. The present price is $2.80 at dock exclusive of bags, but it is quite possible that $3 will be reached within a few months. Lime has maintained its price throughout the year. Hydrated lime remains the same today as it was in 1919, but lump lime has been advanced and quotations are now given f.o.b. plant, instead of in the city. The present prices of lump lime per 300-lb. bbl. are $2.75 for finished, $2.55 for common. It is estimated that these prices will be advanced at least 25c. in the spring. As a single factor in this increase it may be mentioned that barrel staves cost $30 per thousand against $6.50 three years ago. Sand, gravel and crushed stone are quoted at a 25 per cent advance over the present official prices for spring deliveries and these quotations are for use in estimating rather than on sales.

Prophecy is always a difficult and often a dangerous calling. The construction situation is by no means simple. There are a number of factors that must be watched. First, although the recent labor agreement is intended to remain effective until Dec. 31, 1921, it is doubtful whether it can be regarded as being more than a truce. The labor agitation is too profound for prompt solution, living costs are increasing and the need for increased income is growing more imperative. Then, there is a shortage of materials in certain lines, besides continual difficulties in deliveries.

Unquestionably, also, the construction situation will be dependent in some measure on the money market conditions, as they will develop in the next two or three months. How far the efforts of the Federal Reserve Board to reduce the credit volume will extend cannot yet be foreseen. But in view of the relation between credit and price conditions, those who figure on future prices are bound to take this into account.

SPRING PRICES IN NEW YORK FOR THE LAST SEVEN YEARS—THEIR RISE

	Portland Cement (per bbl., with sacks)	Common Brick (per M)	Crushed Stone (per cu.yd.—¾ in.)	Sand (per cu.yd.)	Gravel (per cu.yd.—¾-in.)	C.-I. Pipe (6-inch—per ton)	Beams and Channels (3—15-inch per 100 lb.)	Plates per 100 lb.	Hollow Tile (6x12x12) per block	Linseed Oil (raw in barrels)	Freight to Pittsburgh on Steel (per 100 lb.)
April, 1913	$1 58	$7 00	$0 90	$0 50	$0 85	$24 00	$2 15	$1 61	$0 084	$0 48	$0 16
May, 1913	1 58	7 00	90	50	85	23 50	2 15	1 61	084*	50	.16
June, 1913	1 58	7 00	90	50	85	23 00	2 15	1 61	084*	48	.16
Average	$1 58	$7 00	$0 90	$0 50	$0 85	$23 50	$2 15	$1 61	$0 084*	$0 49	$0 16
April, 1914	$1 58	$5 50	$0 95	$0 50	$0 90	$22 00	$1 85	$1 31	$0 084*	$0 54	$0 16
May, 1914	1 58	5 50	95	50	90	22 00	1 85	1 31	084*	54	.16
June, 1914	1 58	5 60	95	50	90	20 50	1 85	1 31	084*	53	.16
Average	$1 58	$5 55	$0 95	$0 50	$0 90	$21 50	$1 85	$1 31	$0 084*	$0 54	$0 16
April, 1915	$1 22	$5 50	$0 90	.....	$0 85	$20 00	$1 90	$1 36	.....	.....	$0 169
May, 1915	1 22	5 75	1 05	.....	85	20 50	1 90	1 32	.....	.....	.169
June, 1915	1 22	6 00	1 05	.....	85	22 00	1 90	1 37	.....	.....	.169
Average	$1 22	$5 75	$1 00	.....	$0 85	$20 75	$1 90	$1 35	.....	.....	$0 169
April, 1916	$1 72	$8 50	$0 95	$0 40	$0 80	$30 50	$2 50	$2 50	$0 08½	$0 81	$0 169
May, 1916	1 72	7 25	95	40	85	.....	2 50	2 65	08½	81	.169
June, 1916	1 72	8 00	95	50	1 00	.....	2 60	2 75	08½	.....	.169
Average	$1 72	$7 90	$0 95	$0 45	$0 90	.....	$2 55	$2 65	$0 08½	$0 81	$0 169
April, 1917	$2 40	$9 50	$1 20	$0 50	$1 25	$47 50	$3 75	$5 00	$0 13	$1 04	$0 169
May, 1917	2 40	11 50	1 25	50	1 35	55 50	3 80	5 50	13	1 21	.169
June, 1917	2 40	10 25	1 25	50	1 25	55 50	5 00	7 00	13	1 31	.169
Average	$2 40	$10 40	$1 25	$0 50	$1 30	$51 70	$4 15	$5 80	$0 13	$1 19	$0 169
April, 1918	$2 59	$10 25	$1 75	$1 25	$2 00	$55 35	$4 20	$4 45	$0 14*	$1 55	$0 195
May, 1918	2 59	10 00	1 75	1 25	2 00	55 35	4 20	4 45	14*	1 55	.195
June, 1918	2 59	10 25	1 75	1 25	2 00	61 35	4 20	4 45	14*	1 58	.195
Average	$2 59	$10 15	$1 75	$1 25	$2 00	$57 35	$4 20	$4 45	$0 14*	$1 56	$0 195
April, 1919	3 05	15 00	1 75								
May, 1919	2 90	15 00	1 85 1 75	1 25	2 00	$7 70	3 47	3 67	.159	1 55	.27
June, 1919	2 90	15 00	1 85 1 75	1 25	2 00	57 70	3 47	3 67	.153	1 63	.27
			1 85	1 25	2 00	52 70	3 47	3 67	.153	1 76	.27
Average	$2 95	$15.00	$1 80	$1 25	$2 00	$56 03	$3 47	$3 67	$0 155	$1 65	$0 27
General average	$2 01	$8 82	$1 23	$0 74	$1 26	$37 33	$2 89	$2 98	$1134	$1 04	$0 185
Feb., 1920	$2 80	$25.00	$1 85	$1 25	$2 00	$67 30	$3 47	$3 67	$0 2223	$1 80	$0 27

* These hollow-tile quotations f.o.b works, Perth Amboy, N. Y.